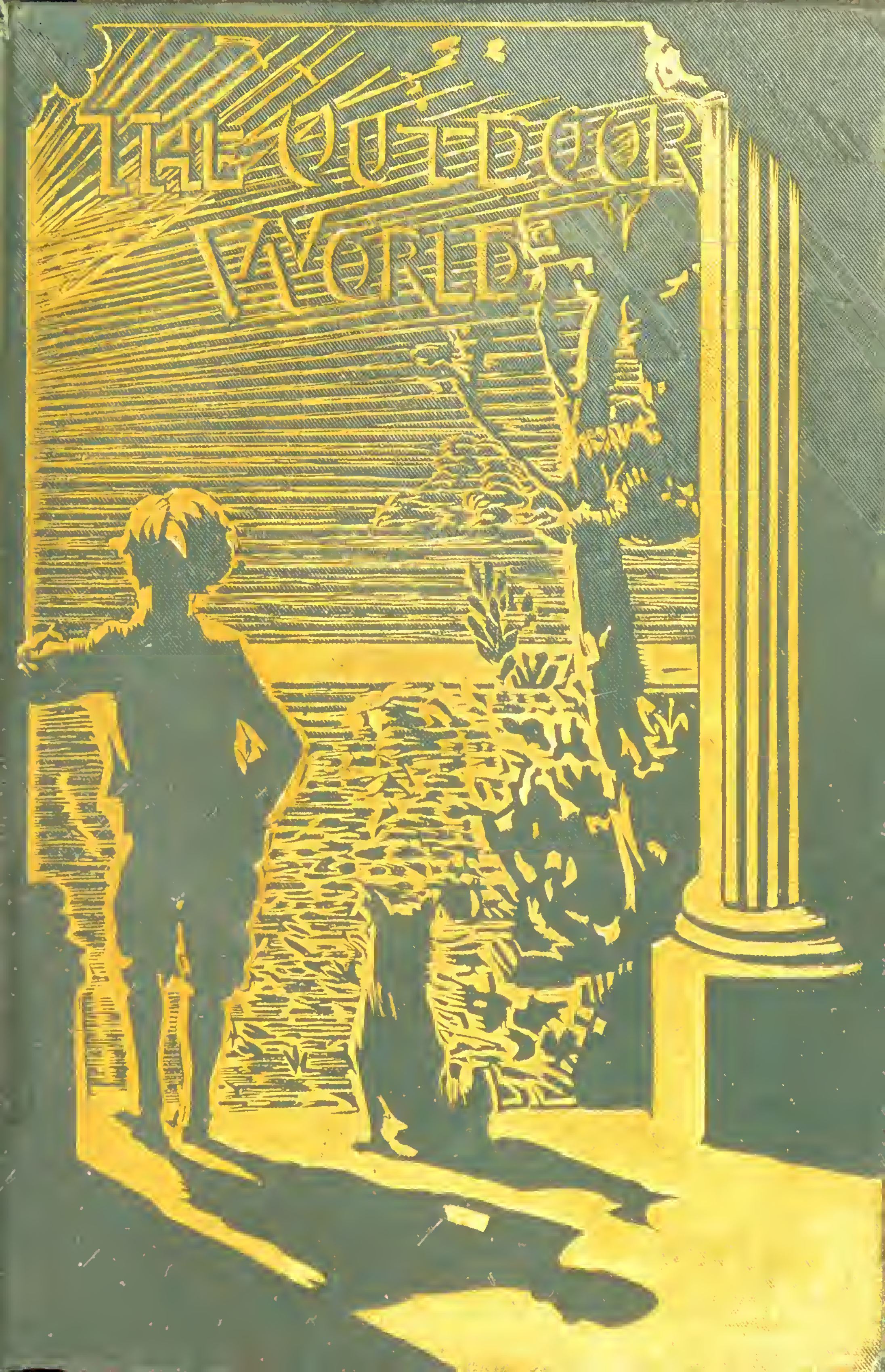
THE OUTDOOR
WORLD

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THE OUT-DOOR WORLD

FRONTISPIECE

THE OUT-DOOR WORLD

OR

YOUNG COLLECTOR'S HANDBOOK

BY

W. FURNEAUX, F.R.G.S.

WITH 16 COLOURED PLATES
AND OVER 500 ILLUSTRATIONS IN THE TEXT

LONDON
LONGMANS, GREEN, AND CO.
AND NEW YORK: 15 EAST 16th STREET
1893

PREFACE

'Boys will be boys!' How often has this expression been used in extenuation of their mischievous propensities! Boys are naturally active, and if they have not the inclination or the opportunity to expend their store of mental and physical energy in some interesting and profitable employment, we shall be sure to find them busily occupied in working out some little scheme by which they hope to derive satisfaction at the expense of their playmates, their neighbours, or some dumb animal. You may almost as well talk to an oak log as tell a boy that he should abstain from such practical jokes as those which give him pleasure at the cost of his victimised school-mates, that it is wrong to annoy his neighbour by damaging his property, or that it is cruel to tie a bundle of ignited crackers to the tail of a cat. If a boy is to relinquish such occupations, we must direct his energies into another channel by giving him a taste for something better. Teach him to play a game of cricket, or to swim; let him have a camera, and show him how to take a photograph; give him a sketch-book, and cultivate a taste for the reproduction of the beautiful in nature and art; or make him a present of a book of scientific recreations. Among such works probably none will be found so fascinating to a boy as those which treat of natural history. Let him once acquire a taste for collecting, preserving, and studying natural history objects, and he has a hobby that will keep him out of mischief, give him healthy employment for mind and body, and occupation for all seasons of the year, both at home and in the field.

It is with a desire to cultivate such a taste, and to assist our boys (and our girls too for that matter) in the varied employments which constitute the 'labour of love' of the true naturalist that these pages are written. I was once a boy myself, and well do I remember the many difficulties and disappointments I experienced while endeavouring to make a useful collection of natural objects—difficulties and disappointments which might have been to a great extent obviated by the perusal of a popular yet scientific guide to the various departments of natural history.

In presenting the following pages to my readers, I do not hope, nor shall I attempt, to convert them into full-blown naturalists. Many years of the most careful observation, combined with much patient work on the part of the student, would be necessary to produce such a result. My only aim is to induce my readers to make a start, and to give them such a general outline of natural history as may form a safe foundation for the future study of any branch of the science that they may desire to follow.

The scope of this volume is large compared with its size. It includes a brief survey of the animal kingdom, with numerous hints on the collection, preservation, and classification of specimens. Many objects which are not generally studied by young collectors are here considered as worthy of a drawer in the young naturalist's cabinet. Thus the reader is made acquainted with the fact that the seaside is not merely a collecting ground for shells and weeds, but that almost every overturned stone between the tide-marks reveals a host of living beings which, although less conspicuous, will repay the time spent in their study. The vegetable kingdom is dealt with in a similar manner. Then follows a short chapter on the collection and arrangement of minerals and fossils.

It is hoped that the detailed descriptions given for the construction of the necessary apparatus and the methods of using it, and the abundance of illustrations, will render this work a thoroughly practical guide to the young collector.

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Errata

Plates XVI. XVII. XVIII. *should be numbered* XIV. XV. XVI. *to be in accordance with the references in the text.*

Plates XIV. and XV. *should be numbered* XVII. and XVIII.

PART I

ANIMAL LIFE

CHAPTER I

PONDS AND STREAMS

I WILL begin by giving my readers a few hints on the collection of the various forms of animal life to be met with in ponds and streams. Young collectors often neglect the study of pond life. Perhaps this may be accounted for by the fact that most of the inhabitants of the water are not to be seen before they are caught. A butterfly on the wing will always arouse their interest ; and, even if it appears to be only a 'White,' yet the probabilities that it *may* be a 'Hawthorn' or a 'Bath' will often result in the insect being netted for a cursory inspection. But when we stand on the edge of a pond, nothing in particular attracts our attention, unless it may be that the brilliant wings of a dragon-fly fix our gaze. We look at a dense mass of duckweed—a screen so thick that we scarcely hope to find a living creature in the water from which it shuts off the sun's rays. A little careful observation will, however, show us our mistake. A small black and shining body suddenly appears on the surface, displacing some of the little green fronds; and after a few seconds' repose as suddenly disappears again. Soon other signs of life become apparent, and then probably we wish some means were at hand by which we could search the new hunting ground.

I can strongly recommend pond hunting to a young naturalist. There is an immense variety of living forms in fresh water. Nearly all these are easily obtained, and generally require but little attention in the aquarium. One single hour spent in pond hunting will supply you with material for interesting occupation at home for many weeks. This form of recreation has the additional advantage

that it may be carried on, if desired, throughout the year. Even in the month of February, when nearly all life is apparently dormant, a 'dip' in a stagnant pool will generally be rewarded with more or less success; but during the warmer months every haul will bring to view a crowd of living creatures.

Apparatus for Collecting in Fresh Water

Many and varied are the appliances recommended by different writers for the capture, conveyance, and preservation of the specimens, many being of a somewhat complicated character. But the best of results may be obtained by the use of the most simple appliances, such as may be fitted up by the most inexperienced and unskilled.

The collector's outfit will consist of a net, a dredging-hook, a dipping-bottle, a can, some wide-mouthed bottles, and a few tin or zinc boxes.

As regards the net, this may be home-made or purchased. Where the means are not very limited, a most convenient form of folding net may be bought. This may be carried in the pocket, and readily screwed on to the end of a stick when required for active service. But it is possible that many of my readers may, either for pleasure or from necessity, desire to make their own. I will therefore give a few hints based on my own experience.

For years I have used a net made as follows: Bend a piece of stout iron wire into the form here represented. Push the two straight ends into a piece of strong brass tubing, about three-eighths

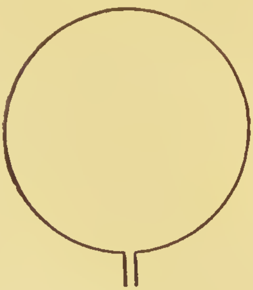

Fig. 1.

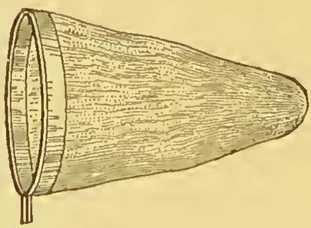

Fig. 2.

of an inch in internal diameter, and three inches long. Then, by hammering the end of the tube, the wire is held in a firm grip. The other end of the tube receives a tough stick about three or

four feet long. A strip of stout calico is now sewn round the iron ring, and to this is attached a net of gauze or book muslin, about eighteen inches deep, conical in form, but with a rounded end.

A metal Y (fig. 3) may be obtained at the dealer's for a few pence, and with this a net frame may be fitted up in a very short time. All that is necessary is to bend a piece of cane of suitable diameter, and push it well into the two narrow arms of the Y. Or a strong Y-shaped twig may be cut, and the ends of a strong cane or piece of wire firmly bound to two of its arms by fine copper wire; the other arm being provided with a ferrule by which it is attached, when required, to a walking-stick.

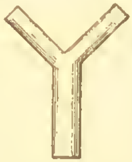

Fig. 3.

A dredging-net is often very useful, especially when the ponds or streams to be searched are rather large. This may be simply an ordinary net, the metal frame of which is thicker than usual—say about three-sixteenths of an inch—and flattened on the off side. The net is tied to a strong string four or five yards long. The other end of the string being tied to the wrist, the net is skilfully thrown out into the water so that it falls flat on the surface, and then pulled in along the bottom. I have often made the same net serve both purposes, changing string for stick, or *vice versâ*, as circumstances required.

When the pond is crowded with weeds it may often be an advantage to weight the off side of the net with a piece of lead.

During several summers I have paid many visits to a certain favourite pond about eight yards in diameter. Here I have always commenced operations by scraping the banks by means of the stick and net. Then, exchanging stick for string, I have searched the less accessible parts, by which means I have undoubtedly secured many a victim driven from the borders by my previous attacks.

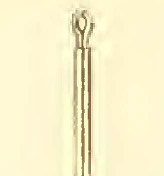

Fig. 4.—A Dredging-hook.

The dredging-hook is very useful for collecting the plants which thrive in our ponds, and which add so much to the beauty of our aquaria. It may, I believe, be purchased, but is easily made. Mine consists of three butcher's galvanised meat-hooks soldered together; but they may be bound together by means of copper wire. Soldering is such a useful art that even the naturalist should learn it. Sometimes the ferrule of

his net splits, his bait can springs a leak, or the joint of his Y gives way; and the repairing occupies only a few minutes.

A dipping-bottle is exceedingly useful, especially when the collector is the fortunate possessor of a good microscope. It consists of a wide-mouthed bottle of medium size, with a spreading rim. A stout wire ring is fastened securely round the neck, and the twisted ends of this serve to fix the arrangement to a stick. Stagnant water usually teems with the lower forms of life, both animal and vegetable; and with the aid of the dipping-bottle samples of water may be collected from different parts of a pond. When it is intended to search for microscopic objects, a hand magnifying lens should always form part of the equipment. Each sample of water removed from the pond is held up to the light and examined with the lens. If abundant signs of life are visible, the greater portion is *gently* poured back into the pond, and the lower richer part, with all its sediment, put into a collecting-bottle for further examination at home.

Many interesting low forms of life may be secured by gently scraping the submerged surfaces of piles and other objects. Of course, this may be done by means of the simple dipping-bottle and stick. My own plan, however, which seems to be in every way satisfactory, is this: A small tin funnel with a wide tube fits firmly in the cork of a wide-mouthed bottle. Two other holes in the cork are covered with fine muslin; and a ferrule soldered to a metal band round the neck of the bottle serves to fix the whole to a stick.

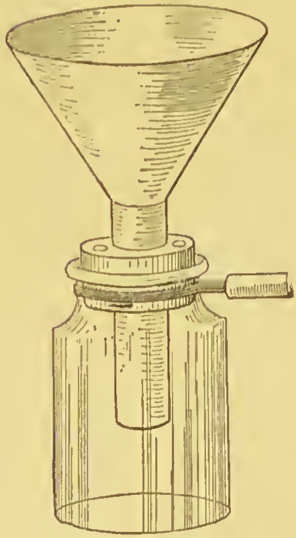

FIG. 5.—BOTTLE FOR COLLECTING LOW FORMS OF POND LIFE.

As the funnel moves upwards in the water, gently scraping the surface to which it is applied, a current of water sets downwards into the bottle, afterwards escaping through the muslin covering the holes in the cork. In this way a large quantity of water may be strained through the apparatus, while the little living beings passing down the funnel are continually adding to the density of the population.

After a time the cork is removed, and the contents poured into

the collecting-bottle. The little animals and microscopic plants thus collected will afford no end of amusement and instruction for many months. They require no further attention beyond the occasional addition of a little water to replace the loss by evaporation, and they will often be found to increase prodigiously in their new home.

The can previously mentioned may be the ordinary angler's bait can, or, as a substitute, a few smaller tin boxes with perforated covers. The perforations need not be many or large, and are easily made by knocking the point of an awl through the metal. These are used for the larger aquatic animals, such as the newts and tritons. It is quite a mistake to suppose that these require a large supply of water during their transmission. Each box should contain a little of some kind of water weed to keep the specimens damp, the weeds themselves being useful for study, and also for stocking the aquaria. Smaller boxes should also be taken for water beetles, larvæ, water spiders, &c.; and great care must be taken to isolate the voracious kinds. The carnivorous beetles and larvæ should not only be separated from the harmless creatures which they so readily attack, but they themselves should not be crowded together; otherwise the collector may find, on his return, a number of dead insects, some having been even reduced to fragments by the powerful jaws of their fellow-captives.

When all the above requisites have been properly prepared, only one thing remains to be done: see that you have provided ample accommodation for the expected enormous and sudden increase of your family. The new abodes may consist of glass jars, tumblers, bell jars, pans, or anything that will hold water. My plan is to keep a large bell jar for the newts and tritons, another for the water beetles and carnivorous larvæ, a third for the less voracious insects and water spiders, and a fourth and smaller one for the microscopic specimens. As a rule, small fishes may inhabit the same water as the newts, and aquatic snails may be distributed in all.

Pond hunting is not by any means a drawing-room sport, and one must not be too careful about his outward appearance in its pursuit. Most ponds and many streams are surrounded by low, marshy banks; so that it is often impossible to keep oneself free from mire during the search. It is therefore absolutely necessary that the collector be provided with a thick and sound pair of boots, not polished, but well greased. Starched cuffs become an abomination, and even the coat-sleeves will generally acquire a consider-

able accumulation of bottom mud, often black and highly odorous. The young naturalist, therefore, if wise, will leave his 'Sunday clothes' at home, and he will take care to wear a good pair of leather leggings.

The Aquarium

Perhaps it will be advisable at this stage to give some hints on the selection and management of aquaria. Where the main object of the collector is to become acquainted with aquatic life in all its phases—to obtain as great a variety as possible for purposes of observation and study—the large single aquarium is a great mistake. A number of vessels will have to be provided, in order that the various kinds of animals may be effectually protected from their enemies. But it is not necessary that the vessels be of any particular or fashionable form. Of course, a large aquarium is very serviceable for fishes and newts, but many of the lower forms are much more easily managed in small vessels. For purposes of study one can do nothing better than fix a shelf across a window that is not exposed to the full blaze of the sun, and arrange on this one or two good-sized vessels for the larger specimens, and several smaller ones to contain the others.

We can quite understand, however, that a strong desire to possess a larger and really ornamental affair may exist, and then the design and general appearance becomes a most important consideration, especially if the proposed aquarium is to occupy a place in the drawing or dining room. The shape of the vessel is, to a certain extent, a matter of taste; but as success will be in proportion to the maintenance of natural conditions, we should make it our aim, as far as is consistent with appearance and other circumstances, to imitate the natural pond or stream.

All natural waters receive their supply of light from the top only; hence the animals which are kept in the inverted bell-jar aquarium are at once placed in an unnatural condition, for they receive the light from all sides. Yet my own experience shows that this form is not by any means unsatisfactory if properly managed.

The rectangular form of aquarium is far preferable to the bell, for it does not magnify and distort the specimens. Such aquaria are rather expensive, but are easily made by those who possess a little mechanical ingenuity. A framework is made by soldering together some pieces of 'angle zinc.' This may then be soldered to a bottom of sheet zinc, supported on a slab of wood, and the sides

and ends fixed with a good cement. The ends may be of slate, the front of thick glass, and the back either of glass or slate.

The selection and application of the cement, however, requires considerable care, since a very small leakage may prove a great inconvenience, particularly with an indoor aquarium. I have seen scores of recipes for stopping and fixing the glass, and have tried several of them, but still feel doubtful as to which is the best. The following is a *good* one: Mix two parts each of litharge, plaster of Paris, and *very fine* sand, and one part of powdered resin. Then make this into a putty with boiled linseed oil and a little driers. This cement will take a few weeks to harden.

Some writers recommend an aquarium which widens out at the top; the object being to expose a larger surface of water to the air. I cannot regard this form as a very sightly one, and the necessity for the widened top disappears when the aquarium is properly stocked. It may be observed, however, that *all* aquaria, of whatever form, should be wide in proportion to their depth.

Now, supposing that the vessel is chosen and procured, how shall we proceed to make the necessary preparations? First obtain from a neighbouring pond or stream a sufficiency of bottom mud to form a layer about two inches deep. I have seen ordinary garden soil recommended for this purpose, but it is more likely that the mud taken from the pond or stream whence we are to obtain our stock of animal and vegetable life will satisfy the requirements of the inhabitants than soil obtained from any other source.

We are now ready for the aquatic plants; and here again we must study the requirements of Nature. Some thrive best in swift waters, and others in sluggish streams and pools. The same remark applies also to the animal life, and especially to fishes. Therefore, specimens that have been caught in running water should be kept under the same conditions; and creatures obtained from ponds should *not* have frequent changes of water.

Some aquatic plants have well-developed roots, and require the presence of either a muddy or a sandy soil; others, like the duckweeds, require no soil, but float on the surface of the water, deriving all their nourishment direct from the air and tho water. The former should be properly set in the soil of the aquarium, which is then, if at all muddy, covered with a moderately thick layer of well-washed sand or shingle. The water is now allowed to run in gently till it reaches within an inch or two of the rim.

If the side of the aquarium which is turned to a window is of

glass, it may be advisable to cut off much of the light entering at that side.

A few rather large stones, loosely piled one on the other, are also useful in providing hiding-places for such animals as require more or less seclusion.

It will sometimes be necessary to cover the top of the aquarium with gauze to prevent the escape of some of the captives. Minnows, for example, will often take a vigorous suicidal leap into the air, and developing frogs, leeches, and the pupæ of the dragon-fly crawl up the glass above the water. But the watchful aquarium-keeper will soon learn for himself when the gauze covering is necessary.

We have now a very important matter to decide. Supposing our aquarium to be stocked with pond life, how often will it be necessary to change the water? Such a question is not to be answered satisfactorily in a few words. We are all acquainted with the ordinary 'fish-globe,' with its contracted top, stocked with a few gold-fish, and placed on a table or suspended in front of a window by way of ornament. And who has not seen the poor fish skimming the surface of the water and gasping for want of air? The form of the vessel is such as to prevent the free aëration of the water, and no means have been arranged for a renewal of air. Fishes and all gill-breathing animals are dependent entirely on the supply of air *dissolved* in the water; and without air they die as we should. This being the case, we should always keep up a sufficiency of dissolved air in an aquarium which contains gill-breathers. Now, this may be done in two or three different ways. There may be frequent changes of water, or the same water may be aërated by some mechanical contrivance; or, thirdly, an appropriate amount of vegetable life may be introduced to maintain what is called the balance of life.

The first of these methods is exceedingly troublesome, especially when the aquarium is small and the demand on the air large; for, in this case, a change may be necessary every day; and, once forgotten, we are sadly reminded of our neglect by the sight of our lifeless pets floating on the surface.

The second method is more satisfactory, but a little ingenuity is required in fitting up the necessary apparatus. Either a current of air is to be forced into the water, or a fine jet of the latter is sent into the air. The better plan is to supply a very fine fountain jet from a small cistern placed high enough to give the

required pressure. A waste pipe is not necessary, for the little cistern may be refilled with water from the aquarium.

Personally, I have no delight in either of the above methods; for, where the lack of vegetable life renders one or the other necessary, the aquarium cannot be a very attractive object. The chief *interest* doubtless lies in the varied movements and habits of the animated creatures, but the general appearance is due principally to the beautiful verdure and the graceful form of the plant life.

I will now point out a better way of aërating the water. Probably you know that plants as well as animals require air. But there is this difference: Animals inhale the oxygen that is in the air, and breathe out carbonic acid gas, while green plants take in carbonic acid gas and give out oxygen. If, then, care be taken in regulating the supply of aquatic plants, the animals will provide these plants with carbonic acid gas, and in return will receive from the plants the oxygen that they need; and the water of the aquarium need seldom be changed. I have at the present time three vessels which have had no change of water for over four months, and yet the health of the animal inmates leaves nothing to be desired.

An aquarium should be put in a good light, but should never be exposed to the direct rays of the sun for any length of time. Low forms of vegetable life (*Confervæ*) will make their appearance as a green growth on the glass, especially if the light is strong. A *little* of this does not mar the beauty of the scene at all; but it sometimes becomes so dense as to be almost opaque. This growth may be retarded considerably by reducing the intensity of the light. A sheet of white or blue tissue paper pasted on the side of the glass which receives the stronger light will prove very effective.

One word more about aquaria: let me recommend you to depart from the old-fashioned plan of stocking your aquarium with a few fish only, as if fishes were the sole inhabitants of the water. Fishes are very interesting, some of them particularly so; but, strange to say, those which exhibit the greatest variety of interesting habits are seldom to be seen in aquaria. The eternal gold-fish is a little overdone. Its colour is too bright when not relieved by a blending of less gaudy tints, to be constantly before one's eyes; and its movements are monotonous compared with the lively and variable antics of many of our little finny friends. An aquarium should be always a changing scene; and every outing should be the means of providing new items in the entertainment.

Making a Start

We are now on our way, and we naturally inquire, 'Which are the best kinds of ponds in which to search?' My advice is: 'Try all.' It frequently happens that a most unpromising pond or ditch is full of interesting beings. Sometimes the black mud and brown frothy scum are very uninviting, and the odour evolved on disturbing the water repels us; yet a few dips may be rewarded by many a beautiful specimen. On the other hand, a pond of clear water, adorned with the lovely flowers and leaves of the water-lily and crowfoot, may be comparatively barren. Frequently we can see the objects we require, and aim straight at them with the net; at other times we dip indiscriminately, and wonder what the result will be. It is not wise, as a rule, to spend much time in walking round a pond merely looking for moving forms at which to strike. Your chances of success are much greater if you are constantly dipping as you go. On reaching the bank of a pond, put out your net as far as you can, and strike the surface of the water perpendicularly with your net. Then drag it in along the bottom, being careful to bring it well home on the vegetation, if any, bordering the banks. Always make for tufts of weeds and submerged grasses, for many animals seek shelter under these, especially after the water has been disturbed by a few strokes of the net. After a few dips, turn out the whole contents of the net—mud, weeds, snails, worms, beetles, larvæ, spiders, and a host of other things—on a piece of bare ground; and, after turning up a few inches of your coat-sleeves, proceed to examine the mass most carefully, and put in boxes the specimens selected.

Leeches

It is probable that most of my readers do not possess such a luxury as a compound microscope, and for this reason I have thought it advisable to pass over all the interesting microscopic inhabitants of our ponds and streams. This I do with very great reluctance, since these minute creatures are quite as beautiful and just as entertaining as the more conspicuous aquatic animals. Let those who have a microscope make a free use of the dipping-bottle I have described, and they will find innumerable treasures in the stagnant pool; and even those who have no better magnifier than an ordinary pocket lens may derive much pleasure and profit in watching the movements of these low forms of life.

We shall start, then, with the leeches, and pass from these to the higher aquatic animals.

Several varieties of leeches inhabit our ponds and streams. They are all soft-bodied animals, divided into a number of ring-like segments like the common earthworm. They are parasites, deriving all their nourishment by sucking the juices from the bodies of living animals.

The *Horse Leech* is very common in our country. Many are the fabulous stories which have been told about this harmless creature, many ignorant persons considering it to be so poisonous that nothing would induce them to handle one. It certainly has teeth, but these are made of gristle only, and could not penetrate the thinnest human skin. Nevertheless, these weapons can easily wound the flesh of the soft-bodied animals on which the leech feeds. It lives principally on worms and grubs; but, failing these, it does not hesitate to suck the blood of its own species. One of my captive leeches was bold enough to enter the shell of a large fresh-water mussel; but it was a fatal venture. The mussel snapped its shells together with a powerful grip that almost severed the leech's body in twain. When the horse leech wishes to swim, it flattens its body into a tape by means of a series of muscles which pass from the upper to the lower surface. It then moves onward with graceful undulating motions.

The *Medicinal Leech*, once common with us, but now rare, is larger than the horse leech, and may be known by the broken

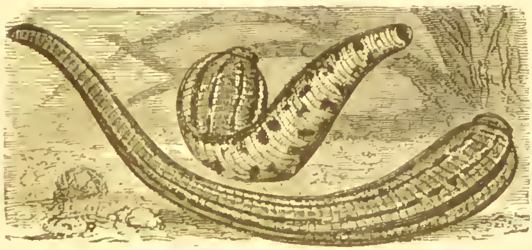

Fig. 6. — The Medicinal Leech.

yellow bands along its back. Its teeth are hard and sawlike, and are worked with a rasping motion by a set of powerful muscles. It has ten eyes, arranged in one curved line.

Fresh-water Molluscs

The term 'shell-fish' is so unscientific that perhaps we had better discard it altogether. The various animals included in this category are not fish at all, nor are they even near relatives of the finny tribe. The class name '*Mollusca*' is applied to an extensive group of animals, all of which are characterised by a soft body, usually inclosed in one or two shells. Most of them have not the faintest trace of an internal skeleton.

The body of a mollusc is covered with a loose, thick, and slimy envelope called the *mantle*, and this secretes the hard layer of limy substance that forms the shell. A kind of membrane on the floor of the mouth bears, in many species, a large number of little teeth, arranged in regular rows; and these constitute the rasp by which the creature grinds the vegetable matter on which it feeds. Nearly all the molluscs are aquatic, the majority of them inhabiting salt water; but some inhabit fresh water, and must now be briefly considered.

Fig 7.—The Teeth of a Mollusc.

The Fresh-water Mussel

The fresh-water mussel (*Anodon*), shown on Plate VIII, is common in some of our ponds and rivers. It is one of the *bivalves* or two-shelled molluscs, very similar to the common edible mussel in form and appearance, but much superior in size.

This creature is easily kept in the aquarium, and is perfectly harmless. Let us watch its movements and habits, after having placed it on a bed of fine sand. At first its shells remain firmly closed, but when it feels itself out of danger it thrusts out from between its valves a fleshy part called its foot. By means of this it slowly turns itself over, and half buries its shells in the sand. As it lies here with its valves gaping, we observe two open tubes slightly protruding, and a very small quantity of carmine or other suitable colouring matter placed gently near the *Anodon* will prove the existence of two currents of water—one entering and the other leaving its body through these tubes. By this means the gills with which it breathes are being continually bathed with fresh water.

Fresh-water Snails

Fresh-water snails are not only ornamental, but even useful, in the aquarium. Some of them feed on the *Confervæ*—the green vegetation which sometimes covers the sides of the vessel so densely—and consequently help to keep the glass clean.

All the snails belong to the *Headed Mollusca*, a division characterised by the possession of a distinct head, with eyes and horns, or feelers. They are all vegetable feeders, and the 'rasp' formed by their numerous small teeth aids them in securing their food. The front portion of this rasp does the chief work, and is, consequently, soon worn down; but the strip of gristle on which the teeth are set is continually growing towards the front, thus renewing the worn part.

The shells of snails are coiled into a spiral, due to the unequal growth of the body, one side growing faster than the other.

The largest British water-snail is the *Paludina* (Plate VIII), which sometimes reaches a length of nearly two inches. It is to be found in the quiet nooks of many of our southern rivers, and, less abundantly, in other parts. Its eyes are placed on the extremities of short stalks. This snail brings forth its young alive, for the eggs are hatched while yet within the body of the parent. When disturbed it retreats within its shell, and then closes the aperture with a horny lid (*operculum*), similar to that of periwinkles and whelks.

On Plate VIII you will see a figure of another large snail (*Limnea stagnalis*), which is very common in stagnant pools and sluggish streams; and the common *Peregra* of the same family, found in similar situations. On the same plate you will also see a representative of the flat spiral molluscs (*Planorbis*), of which there are several species.

Sometimes water-snails lay their eggs on the glass of the aquarium, in which case the gradual development of the young may be easily watched with the help of a magnifying lens.

The table of classification given in the chapter on 'Snails and Slugs' includes both the terrestrial and aquatic molluscs, and will assist the beginner in the arrangement of his collection of shells. The few hints given in the same place on the preservation of molluscs also apply to the aquatic species.

Fresh-water Crustaceans

Before examining the fresh-water species of this group it will be well to learn the general characteristics by which we may recognise its members. The bodies of all the *Crustacea* are composed of a number of ring-like segments jointed together, all the segments being constructed more or less on the same general plan. Each segment bears a pair of limbs. Sometimes two or more of these rings are fused together so completely that the divisions are no longer to be seen; bu in such cases the limbs always remain quite distinct, and thus reveal the true or original number. The Crustaceans have no internal bony skeleton, but are protected by a skin which has either become horny, or else hardened by limy substance.

Our common aquatic species include tho Crayfish, the Fresh-water Shrimp, Water-fleas, and Cyclops.

The Crayfish

The River Crayfish (*Astacus fluviatilis*), which closely resembles the common lobster, is plentiful in many of our rivers. Its skin is hardened by carbonate of lime, which is extracted from the

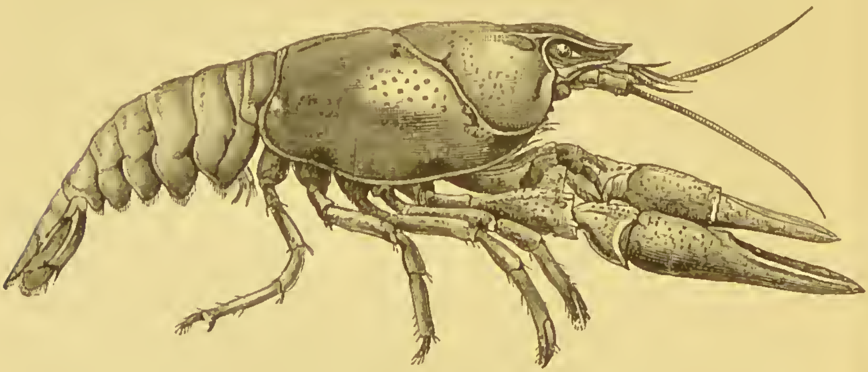

Fig. 8.—The Crayfish.

water; and as this condition is absolutely necessary for the preservation of the animal, we find crayfishes abounding most in the rivers of limestone districts.

During the winter crayfishes spend much of their time in burrows which they excavate, or in natural crevices in the banks of the streams; and large numbers may sometimes bo dug out of these hiding-places during the cold weather. In milder weather they

watch for their prey at the mouths of their burrows with horns extended, but dart backward with a rapid flap of their powerful tails when danger threatens them. In summer they may be seen walking about in shallow water during the cool hours of the evening, but they hide themselves during the heat of the day.

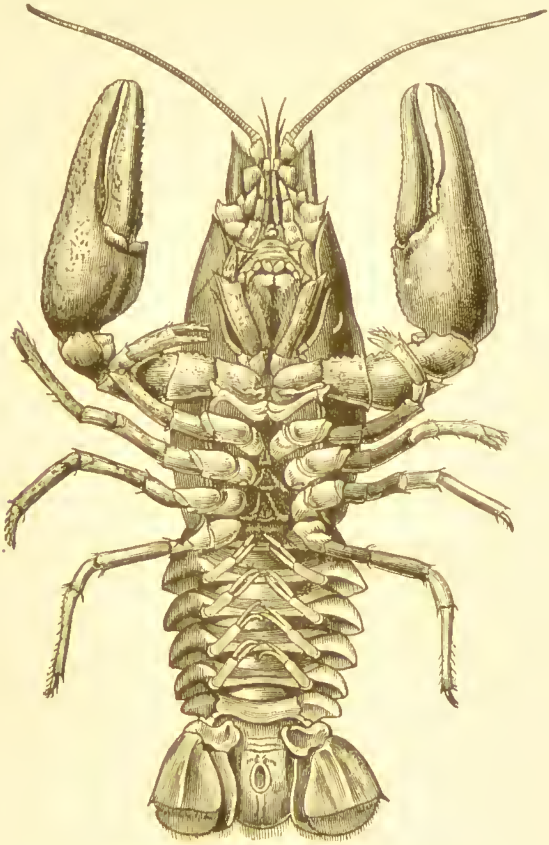

FIG. 9.—THE CRAYFISH (UNDER-SURFACE).

Crayfishes are to be caught in a variety of ways. Baskets baited with frogs or pieces of meat may be let down into the water and hauled up at intervals. Like moths, they are said to be attracted by lights during the night, and are then easily caught with a net. But the most exciting mode of capture is that of wading in the river and pulling the creatures out of their hiding-places by the horns; also turning over the stones and chasing the retreating crayfish as

it smartly flaps its tail with its face to the foe. This is the only method I have tried myself, and recommend it as being a very amusing and lively sport, especially as it often affords an opportunity of testing the power of the creature's claws.

We frequently meet with crayfishes having a limb much less than its proper size. This is generally the result of a fight—a kind of sport in which crayfishes seem to derive as much pleasure as some men. Again, if a limb is seriously injured, the animal snaps it off at one of the joints above the seat of injury; or, if caught by one of its limbs, it will often voluntarily amputate that limb, and rapidly retreat, leaving an inconsiderable portion of its body wriggling in the hands of its captor. In either case a new limb is developed, and at last becomes almost, if not quite, as large as the original.

The best way to keep crayfishes alive is to put them in a very shallow trough with a supply of running water, and some loosely piled stones to afford them hiding-places. As to diet, they are not at all fastidious. They will dispose of water plants, carrots, turnips, cabbage stalks, and other vegetables with a relish. But they are not strict vegetarians by any means, for they will devour snails (shells included), fish, meat, or poultry. The old hard and limy skin thrown off during a 'moult' is crushed in the animal's jaws, and utilised in the formation of a new coat of armour. The female crayfish will even devour her own offspring; and, yet more horrible, the male will kill and eat his own spouse!

Other Crustaceans

Every young collector who has tried his luck in small streams must have met with the lively little Fresh-water Shrimp. A number of these should be put into the aquarium for observation, not only because their movements are interesting, but also on account of their usefulness as scavengers. They are not at all particular as to diet, and greedily devour all kinds of decomposing matter that would tend to make the water putrid. In structure they rather closely resemble their salt-water cousins—lobsters, shrimps, and prawns—and, like the females of these marine relatives, the fresh-water shrimp carries her eggs under her abdomen.

If you examine the water that has been dipped out of a stagnant pool by simply holding it up to the light, you are almost sure to see a number of little creatures, varying in size from a sixth of an inch downwards, darting about actively in all directions. These are the Water-fleas and Cyclops, both of which may be kept in an ordinary

bottle for a great length of time without the slightest attention, and be examined at leisure with a magnifying glass. It must not be supposed that the water-flea is in any way related to the obnoxious

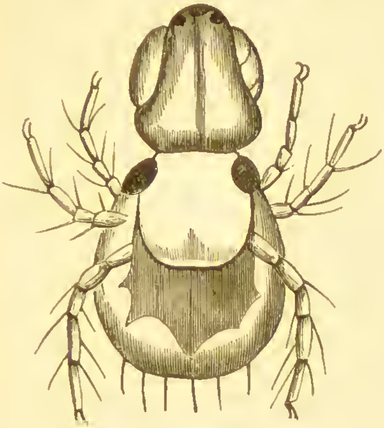

Fig. 10.—A Water-flea, magnified.

Fig. 11.—A Cyclops carrying its Egg-sacs.

parasite of a similar name, for both it and the cyclops are *crustaceans*, while *the* flea is an insect.

Water Spiders and Mites

Spiders and Mites, together with various other small creeping and flying creatures, are often regarded as belonging to the insect world, but in reality they form quite a distinct class (the *Arachnidæ*), differing from all insects in several important particulars. If you examine a spider, you will see that its body is composed of *two* distinct parts. The foremost division consists of the head and *thorax* (chest) combined, and the large and globular hinder portion—the *abdomen*—is joined to this by a very slender waist. Spiders may also be distinguished by their *four* pairs of legs. They all breathe by means of a system of air-tubes, which communicate direct with the atmosphere. The eyes, which are not compound like those of insects, are arranged in little clusters on the front of the head. If the reader will compare these few characteristics with those of insects (p. 20), he will at once perceive the reason for the separation of the two creatures into distinct divisions of the animal kingdom.

The most interesting of the water spiders is undoubtedly the *Argonaut* or *Argyroneta*, more commonly known as *the* water spider. This creature was at one time quite plentiful, but is now comparatively scarce, owing, it is said, to the vigorous search made for it by naturalists and the 'dealers.' We can quite understand that the disclosures of the wonderful instincts of this spider would make it

Fig. 12.—Water Spiders.

quite a pet with aquarium-keepers, but perhaps a lesson may be learned from its almost wholesale destruction.

The *Argyroneta* may sometimes be found among the contents of the net, but it is also to be seen exploring the banks of ponds and streams in search of food. It constructs a dome-shaped cell of silk beneath the surface of the water. This cell is moored to water plants by means of silk threads, and is fixed with its mouth downwards,

just after the fashion of a diving-bell. Having finished the construction of this little dwelling, it rises to the surface, and thrusts the tip of its abdomen out of the water. Then, by a sharp snap of its hindermost legs, it detaches a bubble of air; and, holding this securely between its limbs and its hairy body, it descends to the dome, looking like a ball of silver as it goes down, thrusts its abdomen under the rim, and sets the bubble free. The air is at once caught in the cell, and, after about a dozen such journeys, sufficient has been collected to supply the spider's wants.

The argonaut feeds on all kinds of aquatic insects, and sometimes travels considerable distances from home in search of its prey, but always returns to its dome to suck the juices of its victim. The meal being over, it rests awhile with its head downwards, thus exposing the breathing tubes of its abdomen to the air, and at the same time keeping strict guard over its habitation.

The eggs of the argonaut are laid in a silken cocoon at the top of the dome; and here the young, about a hundred in number, remain till they are strong enough to construct domes for themselves.

Other water spiders frequent our ponds and sluggish streams, but none of them construct a sub-aquatic home like the species above described.

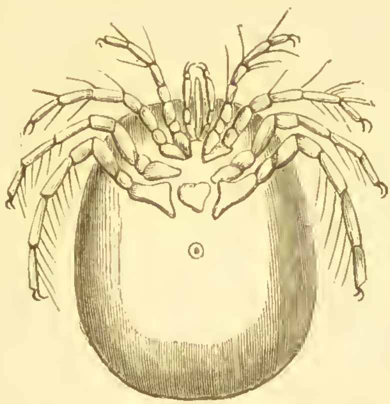

Fig. 13.—Water Mite, highly magnified.

Mites resemble spiders in form, and may generally be known by their four pairs of legs; but some of them, during their earlier stages, are seen with only two or three pairs of limbs properly developed. These little creatures are sometimes seen swimming freely in the water, or creeping along the leaves and stems of the water weeds; but some of them, especially when young, are unable to get about without assistance, so they attach themselves to the bodies of water beetles and water scorpions, thus obtaining a very convenient ride at an extremely low fare.

Fresh-water Insects

We now come to the class *Insecta*, the most numerous and the most highly developed of all the animals without backbones. These are so widely distributed that it is almost impossible to find a place in which they do not live. The summer air is full of their hum; every little pond harbours its thousands, every crevice in the soil or the solid rock provides them shelter, every tree and shrub supplies them with food; and many seek shelter in the habitation of man.

The term insect is applied by the uninitiated alike to all small animals. Spiders, mites, centipedes, and woodlice are all popularly known as insects. But let us see what an insect really is. The name is derived from two Latin words which signify 'cut into,' and itself marks one of the chief distinguishing characteristics of the whole class, for the bodies of all insects are distinctly divided into three parts—the head, the thorax, and the abdomen—and the depression between these parts is often so deep that they appear to be connected by a mere thread. Look, for instance, at the very slender neck of the house-fly, and the thin waist of the wasp.

Insects also undergo changes of form (*metamorphoses*). Thus, from the egg is hatched the *larva* or grub. This, when full grown, changes into the *pupa*, or chrysalis, from which emerges the *imago*, or perfect insect.

The *larvæ*, as a rule, are voracious feeders, and grow very rapidly, undergoing a series of moults or changes of skin. When fully grown they cease to eat, and, after casting their skins for the last time, change into the pupal state, usually concealing themselves underground, or in a cocoon of silk or other material which they construct for their protection.

The *pupa* is usually very inactive, and eats nothing; but a change is gradually taking place within it, for the organs of the perfect insect are in process of formation. At last the time arrives for the final metamorphosis. It breaks its loosened skin, struggles out of its burrow or cocoon, and seeks a place where it can expand and dry its wings. It is now the perfect insect or *imago*, endowed usually with enormous powers of flight, and capable of propagating its kind.

The perfect insect has always three pairs of legs, one pair being appended to each of the three segments which form the thorax.

Many, like flies and gnats, have but one pair of wings, always jointed to the middle segment of the thorax. Others, such as butterflies and moths, possess two pairs, attached to the second and third segments. Others, again, like fleas and lice, have no well-developed wings for flying.

All insects have one pair of antennæ, with some, very conspicuous and exquisitely formed, but with others, so small as to escape general observation. Insects are further characterised by the peculiarity of their breathing apparatus, which consists of a set of air-tubes called *tracheæ*, kept open by an elastic thread coiled spirally, just like the wire in an india-rubber gas-pipe, and communicating with the outside air by openings in the skin called *spiracles.*

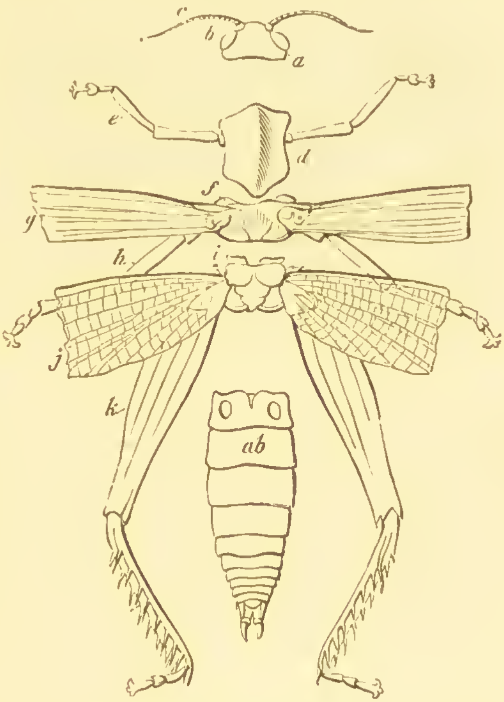

FIG. 14. GRASSHOPPER, SHOWING THE STRUCTURE AND COMPOSITION OF AN INSECT'S BODY.

a, head; *b*, eye; *c*, antenna; *d*, thorax, foremost segment; *e*, foremost pair of legs; *f*, middle segment of thorax; *g*, foremost pair of wings; *h*, second pair of legs; *i*, hindmost segment of thorax; *j*, posterior pair of wings; *k*, third pair of legs; *ab*, abdomen.

Having now observed the chief marks by which insects are distinguished from all other animals, we are in a position to define precisely what an insect is. It is a jointed animal, with a body of three divisions, undergoing metamorphoses, having always three pairs of legs in the perfect state, and breathing by means of tracheæ.

Water Bugs

We will start our observations on the aquatic insects with a brief notice of the Water Bugs (*Hydrocorisa*). These have very short

antennæ, almost concealed beneath the eyes. The front legs are not very long, and are capable of being folded in such a manner as to be useful in seizing and holding their prey.

The family of Water Boatmen (*Notonectidæ*) is very well known, especially the Common Boatman (*Notonecta glauca*), which may be found among the net haulings from ponds almost everywhere. These insects are happily named, for they are decidedly boat-shaped, and the hind legs, which are about twice as long as the others, stand out at right angles like the oars of a boat, and are provided with fringes of stiff bristles for blades. The Latin name is also well applied, for *Notonecta* means 'back swimmer,' and all the members of the family swim on their backs. These insects should be watched in the aquarium, for their movements are extremely interesting. They paddle themselves about with great activity, always nicely 'feathering' their oars by depressing the bristles after every stroke. When taken out of the water they act very clumsily, sometimes walking with their four short legs, and dragging their oars behind them, and often giving a succession of leaps by a sharp motion of the latter. During the night they often leap out of the water and take short flights from pond to pond.

FIG. 15.—WATER BOATMAN (*Glauca*).

The boatman is a carnivorous insect, feeding on any living thing which it is strong enough to conquer. It holds its prey firmly with its front legs, and, after stinging it to death with its sharp beak, proceeds to suck its juices till nothing is left but an empty skin. The beak is also used as a weapon of defence, as I have proved many times when holding these creatures in the hand. It will pierce the skin, producing a sharp pain like the sting of a bee, but not so intense.

It breathes by means of an air cavity between the wings and the upper surface of the body, and often reposes on its back with the tip of the abdomen just above the water, so as to allow this cavity to communicate with the atmosphere. Sometimes, however, it will seek another experience by turning itself over and basking in the hot sun with its back out of the water.

The boatman spends all its three stages in the water. The larva and pupa both resemble the perfect insect in general form, but the

larva has no wings, and those of the pupa are imperfectly developed. The eggs may be found in spring on the leaves of water plants, and the young larvæ are hatched in April or May.

The *Corixa* is very similar to the *Notonecta* in form and habits, but is not nearly so common.

FIG. 16.—*Corixa*, SLIGHTLY ENLARGED.

FIG. 17.—THE WATER SCORPION.

The Water Scorpion (*Nepa cinerea*) forms a bold contrast to the pretty and active boatman. It is a very unsightly and sluggish creature, delighting in stagnant and fœtid waters. The term 'scorpion' has been applied to it on account of the scorpion-like appearance of the front pair of legs, which are bent round towards the mouth to serve as a pair of pincers. Its body is flat and leaf-like, and of a colour resembling that of the mud in which it lies concealed when watching for its prey.

When the water scorpion is at rest you will notice that it is either on the mud in very shallow water, or on water plants near the surface, with its long and pointed 'tail' thrust upwards so that the end projects out into the air. This 'tail' is really a pair of grooved rods, which, when placed together, form the creature's breathing tube.

The scorpion does not *eat* its prey, but sucks out all the juices from its body. I have before me, as I write, a vessel containing about a dozen water scorpions, and about the same number of the dead larvæ of the dragon-fly. The latter have been killed by the scorpions, and their dead bodies, which have not lost their original form, have been sucked till they are transparent.

Our next example of the water bugs (*Ranatra linearis*) is quite a graceful object compared with the ugly *Nepa*. It is also

far more active, and will sometimes boldly defend itself against its enemies.

All insects have very light bodies, and even in cases where the build seems bulky and heavy, a great deal of the interior is occupied

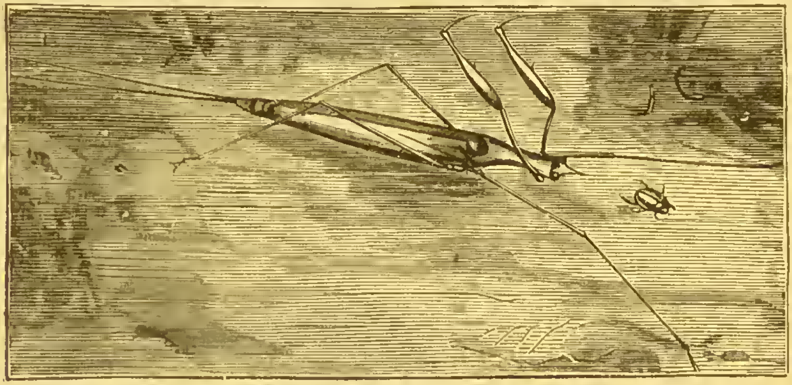

Fig. 18.—*Ranatra.*

by air-sacs and air-tubes. A certain group of the bugs (*Hydrometridæ*) have bodies so very light that they actually run on the

Fig. 19.—A Water Gnat (*Hydrometra argentata*), magnified.

Fig. 20.—Water Gnat (*H. gibbifera*), enlarged.

surface. These are the Water Gnats, which we see during the summer in almost every pond.

Let us catch one of them, and examine its wonderful feet. The microscope shows that they are covered with fine velvety hairs,


1
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which, like the feathers of the duck, will not become wet, and are resisted by the water beneath them with sufficient force to support the body of the owner. As we watch them on the water we observe that they run on *two* legs as we do, using for this purpose the middle pair. The front legs are always held out in readiness to seize their prey, and the hind pair, projecting backwards, form the steering gear.

Some of the water gnats fly well, and when they alight on the surface of the water they may be seen folding their hind membranous wings, and tucking them snugly under the front horny pair with their legs.

Aquatic Nerve-winged Insects

This order, the *Neuroptera* or *Nerve-winged Insects*, is so named on account of the delicate network of *nervures* which support the transparent membrane of the wings, giving them a beautiful lace-like appearance.

The group includes the beautiful Dragon-flies (*Libellulæ*), with wings of such delicacy, and colours so brilliant, as to make them in no wise inferior to the butterflies in beauty.

In many parts they are known as horse-flies or horse-stingers, on the supposition that they are guilty of annoying horses and cattle; but this is wrong, for they live entirely on insects, and have no occasion to attack quadrupeds.

Several species inhabit our country, some of which are shown on Plate I, but they resemble each other so closely in structure and habits that the following account applies almost equally to all.

The larvæ may be dredged out of our ponds, where they lie concealed in the mud, with their large and prominent eyes on the look-out for their prey. Their jaws are covered with a peculiar 'mask,' which can be thrust out till it is about half the length of the body. This mask is really an enlarged lower lip, extending backwards on the front lower portion of the thorax, and is provided with a pair of jaws or pincers, with which the larva seizes its prey. Thus the creature can lie motionless and unseen in the mud, and seize its unwary victims by simply shooting out its mask.

These larvæ have a very remarkable breathing apparatus, which serves also as a means of locomotion. The breathing cavity lies along the back of the abdomen, and if you watch one at rest you can see this cavity pulsating regularly. But now disturb it, and it will make a sudden dart without moving a limb, just as if it had

been pushed on by some magic force. Now put the larva in a glass of clear water with very fine sand at the bottom, and you will notice that each time the creature darts *forward* a little cloud of sand is shot *backward*. Thus the secret is revealed: the larva suddenly contracts its breathing cavity, forcibly ejecting the water it contained, and the recoil starts the body in the opposite direction.

The pupa of the dragon-fly is very similar in appearance to the larva, but may be distinguished at once by the short imperfect wings.

FIG. 21.—LARVA OF DRAGON-FLY, SHOWING THE MASK, AND THE PERFECT INSECT EMERGING FROM THE PUPA-CASE.

Unlike most pupæ, it retains the voracious habits of the larva. After the dragon-fly has spent about eleven months in its two preparatory stages, living all the time in water, it climbs up the stem of a water-weed to prepare for its final change. Here the pupal skin splits along the back, and the perfect insect gradually works itself out of its old coat, and leaves it still attached by the claws to the plant. The perfect fly now remains suspended on the weed till its beautiful wings have expanded and dried. This does

not take long, and, as soon as the wings are sufficiently stiff, the dragon-fly begins its short aërial life.

The flight of some of the larger dragon-flies is so rapid that it is very difficult to catch them on the wing. They dart about, chasing, tearing to pieces, and devouring all kinds of insects. They have the remarkable power of suddenly reversing the action of their wings, so that they can stop quickly and dart backward in the air.

The jaws of the dragon-fly are very powerful. It will allow itself to be fed while held in the hand by the wings, but probably it is anger rather than hunger that prompts it, for it will savagely chew up small sticks and straw when brought within its reach.

Fig. 22.—The May-fly.

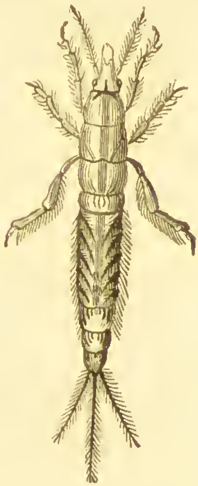

Fig. 23.—Larva of the May-fly.

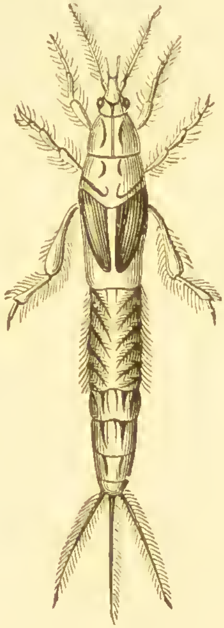

Fig. 24.—Pupa of the May-fly.

The May-fly (of the family *Ephemeridæ*) has a life-history very similar to that of the dragon-fly, but there are a few interesting points of difference which we will briefly note. The eggs of this insect are allowed to *fall* into the water, all being united into one little mass. The larva burrows into the mud at the bottom of the

pond or stream, and there feeds on decayed vegetable matter. If you require these larvæ for the aquarium, you must dredge in some of the pond mud with your net; or you may stir up the mud with a stick, and then capture the larvæ which have been driven out with the net.

After spending about two years in the larval and pupal states, the insect leaves the water towards the close of a day. Its skin then splits along the back, and out comes a rather heavy-flying insect, which is called the *false-imago*, and settles at once on the bark of a neighbouring tree. Here it rests for a time, after which the second skin splits, and from it escapes the perfect and active little May-fly, leaving the 'false' skin still attached to the tree. The perfect May-fly has no mouth, and requires no food, for it is destined to live for a few hours only! It joins the merry company over the water's edge, and dances during the evening twilight with an incessant up-and-down motion. Before the sun rises in the morning it has finished its frolicking, deposited its little cluster of eggs, and fallen dead, with all its playmates of the previous evening, either on the water or near its edge. It has lived two years in its preparatory stages, but in its perfect form it has, perhaps, not taken one single peep at the sun.

FIG. 25.—CADDIS-FLIES.

Our last example is the Caddis-fly, known also as the Cad, Grannum, and Cockspur. This is well known to anglers, for both the larva and the perfect insect are admirable for bait. The fly itself is not swift on the wing like the dragon-fly, but it runs quickly, and it can do this even on the surface of water. The chief interest, however, lies in the larva, which constructs a home for itself out of materials found in the water. It cements together pieces of stick, sand, shells, dead leaves &c. into a little tubular habitation suffi-

ciently long to completely cover its body. Then the larva, knowing that its soft, fat, white body is highly prized as a delicacy by the fishes and predacious larvæ, never ventures to expose any portion save its hard head and its legs ; but this is sufficient to enable it to walk about, while the claspers at its hinder extremity serve to fix it to its 'case.'

Very interesting experiments may be performed to test the building powers of the caddis larva. If you pull a few of them gently

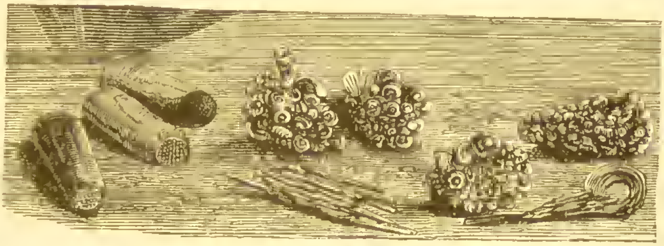

FIG. 26.—CADDIS CASES.

out of their homes and place them in a clean glass of water, they will construct new ones before your eyes, and of any material you may please to give them. In this way I have obtained pretty little tubes composed of glass beads, small pins, shells, &c.

Aquatic Two-winged Insects

This order (*Diptera*) contains a large number of insects, all of which possess two transparent and veined wings. The hind pair of wings is not in reality absent, but only imperfectly developed. If you catch one of these creatures—the common blow-fly or daddy-long-legs, for example—you will easily make out a pair of rod-like and knobbed structures just behind the bases of the wings. These are the *halteres* or *balancers*, supposed to be of great assistance in regulating the flight, and are the representatives of the hind pair of wings in other insects. The *Diptera* are further distinguished by the size of the eyes. These are always very large comparatively, and, in some instances, certainly make up the greater part of the head.

Most of the two-winged insects are inhabitants of the land and air only, but a few very interesting species are more or less aquatic in their habits, and will therefore be best considered now.

The troublesome little gnat (*Culex pipiens*) is a well-known example. Let us look briefly into its wonderful structure and

history. Catch one of these sportive little creatures and place it under the microscope, and you cannot but regard it with wonder. Even the instrument with which it wounds us is sure to call forth our admiration. The exquisitely tinted scales which adorn the wings and the beautiful feathered antennæ of the male are always favourite objects with microscopists. The male gnat is a perfectly harmless fellow; but look at the instrument of torture that arms his mate. It is a little case, consisting of two parts, and containing a bundle of lancets which can not only pierce through our skin, but also inject an irritating liquid into the wound.

If you want to study the life-history of the gnat you need go no farther than the open water-butt. Here you may see Mrs. Gnat with her fore legs on a floating straw or weed, her middle legs resting on the water, and her hind legs carefully arranging her new-laid eggs into the form of a little boat. One by one she lays the eggs and glues them together. When she has finished her labours you may examine the little floating boat. Ruffle the surface of the water and it will not turn over. Turn it completely over and it will immediately right itself again. So here it remains on the surface, probably deriving benefit from its double exposure to air and water.

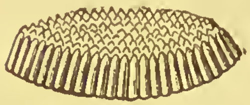

FIG. 27.—EGGS OF THE GNAT, MAGNIFIED.

Shortly the young larvæ appear, and you may observe their transparent bodies at the top of the water, with the breathing tubes just above the surface. When fully grown the larva changes to the pupa. It is now a very different creature. Its back is humped, and the hump is raised slightly out of the water, for it has now discarded its old breathing tube, and receives its air supply by means of two appendages on its back. It does not eat, nor could it if it wished, for its pupal skin completely covers its mouth. Yet it is active, and may be seen wriggling about in the water, alternately straightening and bending its body.

Now comes the final transformation scene. The pupa raises its back out of the water. The portion of the skin thus exposed becomes dry and splits. The rent enlarges rapidly, and the dry skin opens so as to form a little boat. Little by little the perfect gnat emerges from its torn garment—first the head, then the thorax, and finally its abdomen. The gnat now raises its body till it looks as if the boat were supplied with mast and sail. Then it leans over and rests its front legs on the surface of the water, which is sufficiently

firm to support its fragile body. Watch it a little longer and you can see its wings expand. Soon they are dry and rigid, and in a moment the gnat is frolicking in the air.

FIG. 28.—THE STAGES OF THE GNAT, SHOWING THE LARVA, PUPA, PERFECT INSECT EMERGING, AND MALE AND FEMALE FLYING.

Aquatic Beetles

The *Coleoptera*, or Horny-winged Insects, are well represented in our ponds and streams. Dip your net into any weedy pool, and you will almost invariably turn out a few species of 'water beetles.' Put them all in a tin box or can with plenty of wet weed—no water being necessary for their transmission—and, on arriving home, throw the whole into a large vessel of water, and observe them at your leisure. You will probably find among them species ranging from about a twelfth of an inch to considerably over an inch in length. Observe how actively they dart about. Their bodies are smooth and boat-shaped, so that they are enabled to move through the water with but little resistance. The hind legs are long and fringed, and are used exactly after the fashion of a pair of oars. Take one of the insects in your hand, and gently lift up the horny outer wings (the *elytra*), and beneath will be seen the neatly folded transparent wings used in flying. Notice, too, their powerful horizontal jaws, and you will not be surprised at their voracity. You may feed them on worms, fishes, frogs, insects, or any kind of meat, raw or cooked; but, if not well supplied, they will soon take to eating one another.

The water beetles generally remain in the pools and streams throughout the day, but often make long excursions from one patch of water to another during the night. In some cases their flight is somewhat lofty, and when they find themselves vertically over a favourable piece of water, they seem to let themselves drop into it. Many a water beetle has been deceived on a clear night by the reflection of the moon's rays from glass, and has fallen with a crash on the roof of a greenhouse.

The finest of our carnivorous water beetles is the Great Water Beetle (*Dyticus marginalis*), a very interesting object for the aquarium. It is very common in ponds, and its voracious larva may be dredged in with the mud and weeds. Those who keep the *Dyticus* in captivity must remember its nocturnal habits. If the aquarium contains much floating weed, the insect can get a foothold to enable it to start its flight; but this may be prevented by a covering of gauze. The attitude of *Dyticus* when at rest is a curious one. When undisturbed it keeps at the surface, with its head inclined towards the bottom, and the tip of its abdomen just a little out of the water, and thus it remains perfectly still, 'resting on its oars.' It is watching for some dainty morsel with which to satisfy its keen appetite. But why this curious attitude? When the beetle

dives beneath the surface you will observe a bubble of air entangled between the tip of the abdomen and the elytra, shining in a strong light like a globule of quicksilver. This is the supply of air for its respiration, and must, of course, be renewed at frequent intervals; but as long as the *Dyticus* remains at rest with its hinder extremity just out of the water, there is a free communication between the outer air and the breathing space beneath the elytra.

When you grasp a *Dyticus* in your hand, you will almost invariably find it endeavouring to slip *backward* between your fingers, and, unless your skin is moderately thick, you will probably learn why. There are a couple of sharp spines underneath the abdomen close to the hind legs. These are directed backward, and are thus rendered serviceable by the movement of the beetle just mentioned.

Fig. 29.—*Dyticus marginalis*, Male.

Fig. 30.—*Dyticus marginalis*, Female.

It has another peculiar means of defence. When irritated it discharges a whitish fluid, of a very disagreeable odour; should any of this touch the skin, something more than an ordinary wash will be necessary to remove the objectionable perfume.

The larva attains a length of about two inches, and may be kept in the same aquarium as the perfect insect. In ponds it often lies concealed in the mud, and, being of much the same colour as this mud, it is not easily seen by the unwary beings who live in danger of its hungry jaws. It breathes by means of a pair of fringes which you will observe at the end of its tail. When it dives beneath the surface it carries down a small supply of air entangled among the hairs of this fringe; but it often rests at the surface in an inclined position like the perfect insect, with the tail-fringe projecting a little above the water. The larva is as voracious as the perfect form, and

by means of its hollow jaws it will suck the juices of its victims, leaving little more than an empty skin.

When about to change to the pupa, it creeps up the bank of the pond, burrows into the damp earth, and constructs a little oval cell

Fig. 31.—Larva of *Dyticus*.

Fig. 32.—Pupa of *Dyticus*.

in which to conceal itself. If the weather is genial, it emerges as a perfect *Dyticus* in about three weeks; but if the winter winds are near at hand it takes a long nap in the pupal state, postponing its final change till the warmth of the spring sun penetrates into its cell.

Fig. 33.—*Agabus biguttatus*, magnified.

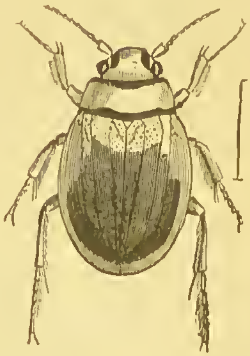

Fig. 34.—*Pelobius Hermanni*, magnified.

The *Dyticus* may be taken as a type of its family (the *Dyticidæ*), two other members of which are figured (figs. 33 and 34); but our limited space will not admit of even a short description.

There is another family of carnivorous water beetles—the *Gyrinidæ*—so named from their peculiar habit of whirling round and

round on the surface of the water. The best known among these is the common Whirligig (*Gyrinus natator*), a little beetle, only a quarter of an inch long, and of a blue-black colour. The whirligigs are gregarious, and little companies of them may often be seen dancing a merry round in some sheltered corner of a pond. They feed on smaller insects, but are themselves the prey of the birds above and the fishes below. In order to compensate for this twofold peril, their eyes are divided so that they look like four. With the upper divisions they watch for enemies above, and the lower portions are submerged to enable them to see distinctly in the water. Threaten them from above, and they dive rapidly to the bottom; but if in danger of some evil-disposed fish below, they jump up

FIG. 35.—THE WHIRLIGIG.

FIG. 36.—LARVA OF THE WHIRLIGIG.

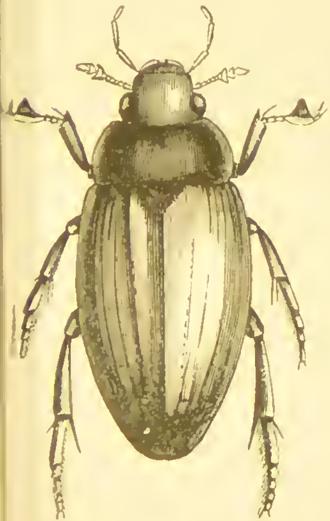

FIG. 37.—*Piceus*, MALE.

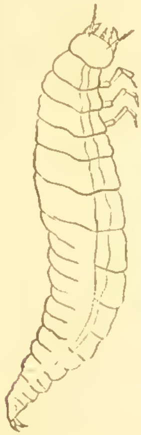

FIG. 38.—LARVA OF *Piceus*, NOT FULLY GROWN.

FIG. 39. PUPA OF *Piceus*.

from their liquid playground and take to their wings. The larva, shown in fig. 36, may be dredged out of ponds, and the cocoon may

be seen plentifully towards the end of summer, attached to the leaves and stems of water plants.

Our last example of the water beetles is the Black Water Beetle (*Hydrous piceus*). This one is even larger than *Dyticus*; in fact, it is the largest of all the British Coleoptera, with the exception of the beautiful 'stag.' It was once very plentiful in ponds and streams round London; but, being perfectly harmless to animal life, it has become quite a pet with aquarium-keepers; and the consequent demand for it has led to such a vigorous search on the part of the dealers who call themselves naturalists, that scarcely a specimen is now to be found. The female *Piceus* is provided with a spinning apparatus at the tip of her abdomen; with this she constructs a turnip-shaped cocoon on the stem of a water plant, in which she deposits about fifty eggs. As soon as the young larvæ are hatched they make for the water, where they feed on molluscs and other aquatic animals till they attain a length of three inches.

Fresh-water Fishes

All the species of aquatic animals which we have described belong to the great division *Invertebrata*—animals without backbones; and, in passing onward from the insects to the fishes, we leave this division for the *Vertebrata*, or animals possessing backbones. Perhaps, then, at this stage, we cannot do better than spend a short time in noting the chief characteristics which distinguish these two primary groups of the animal world. None of the beings previously mentioned have internal skeletons; but the *Vertebrata*, which include fishes, amphibians, reptiles, birds, and mammals or milk-giving animals, all have some kind of internal framework, the chief part of which is termed the *backbone* or *vertebral column.*

This vertebral column generally consists of a large number of separate bones (*vertebræ*) placed together end to end, thus forming a long, flexible axis, extending throughout the length of the trunk of the body.

The backbone, being hollow, forms a kind of tube, through which a great nerve (the *spinal cord*) proceeds from the base of the brain.

In the *Vertebrates*, too, we observe a great cavity in front of (or below) the backbone—the cavity which holds the organs of digestion and circulation; while in the *Invertebrate* animals, with no bony

column, the nervous system (if any) has no separate tube, but shares the great cavity with the various internal organs.

Fishes constitute the lowest class of the vertebrates. They are all aquatic animals, and their structure is, in all cases, peculiarly adapted for their native element. The round-bodied fishes always taper at both ends, and the flat-bodied species always present sharp edges to the water as they move along; and thus the resistance offered to their movements is but slight.

Beneath the backbone, in the fore part of the body, are a number of ribs, arranged in pairs, surrounding the internal organs. The limbs are fanlike fins, usually four in number, and arranged in pairs, corresponding with the two pairs of limbs in the higher verte-

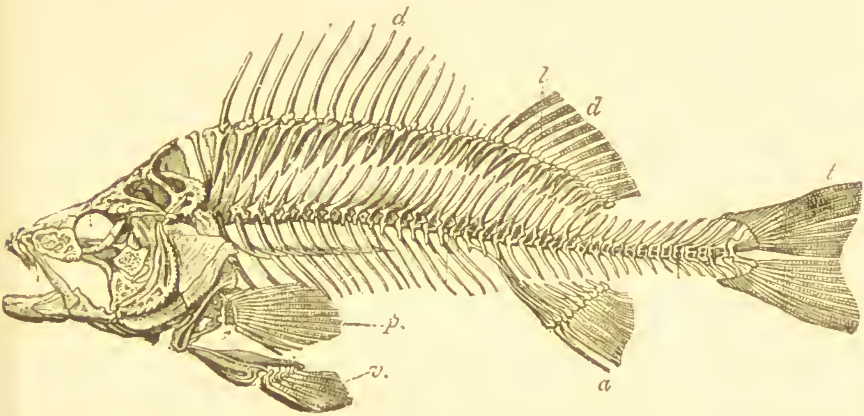

FIG. 40.—SKELETON OF A FISH (PERCH).
d, dorsal fins; *v*, ventral fin; *a*, anal fin; *p*, pectoral fin; *t*, tail fin.

brates. Besides these there are fin rays extending along the back, and also on the under-surface; but these are not to be regarded as limbs, since they are merely extensions of the outer skin.

Fishes are all cold-blooded animals, their bodies being always approximately of the same temperature as the water in which they live. The heart consists of two divisions: one, the *auricle*, receiving the blood from the veins; and the other, the *ventricle*, pumping the blood to all parts of the body. At each circulation a portion of the blood is forced through the gills for the purpose of being aërated. Everyone has observed that fishes, while alive and in water, are, apparently, drinking without intermission; but the water taken in at the mouth at each gulp does not pass into the stomach with the

food: it is discharged through wide slits immediately at the back of the head. In these slits are placed the gills—fringe-like organs, richly supplied with blood-vessels, and consequently of a deep red colour. Here the blood is separated from the water by only a very thin and transparent membrane—so thin, indeed, that the dissolved air which the water contains is readily absorbed into the vital fluid. Thus all fishes, together with the gill-breathing *invertebrates*, are provided with an apparatus by means of which air is filtered from water, but which is not capable of effectually aërating the blood when in direct contact with the free air.

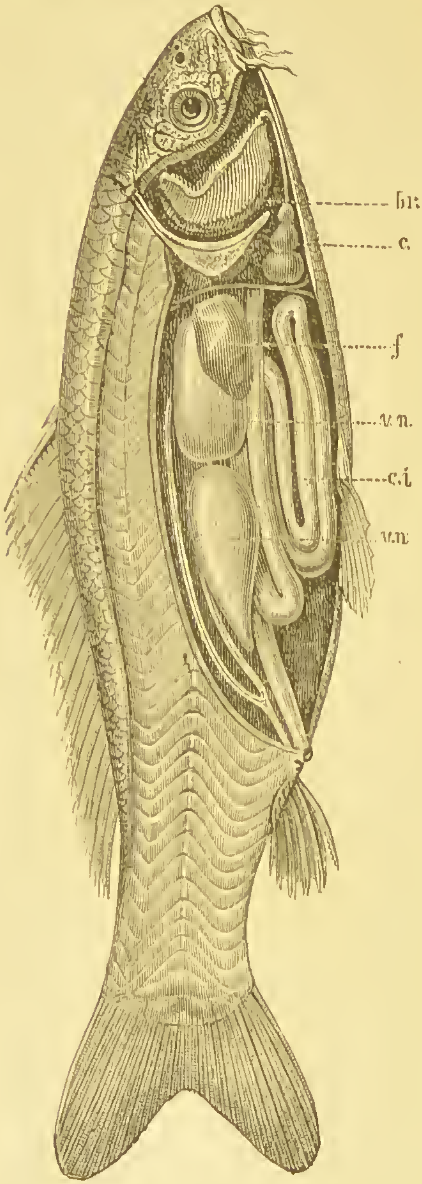

FIG. 41.—ORGANS OF A FISH (CARP).
br, gills; *c*, heart; *f*, liver; *vn*, swimming bladder; *ci*, intestine.

Some fishes live entirely at the bottom of their watery home, deriving their food from smaller animals which conceal themselves among the stones, mud, and weeds; but others are always suspended in the water, and feed on beings which swim about as freely as themselves. The former are heavier than water, and could not rise to the surface without some effort. The latter, however, are of the same specific gravity as the water; and are, moreover, provided with an air-bladder, by which they are enabled to regulate their specific gravity according to the density of the water at any particular depth at which they desire to swim or rest.

The young fishes come from eggs, which are laid in enormous numbers. It has been calculated that the roe of a single fish sometimes contains over a million eggs, and that if all the eggs of the various species (more than twelve thousand in number) were to develop into mature animals, our seas and rivers would soon become so thickly populated that they would have no room to move. But, thanks to their numerous enemies, the greatest of which are the fishes themselves, the majority of the young are devoured, and our waters are thus prevented from becoming stagnant masses of writhing and seething beings, struggling for the last share of food and air.

Fishes for the Aquarium

Some of our fresh-water fishes thrive well in the aquarium, and become very tame and interesting pets. They should always have plenty of room, and, if you are to be very successful in their management, you must keep them in their natural conditions as near as possible. In all cases give them a liberal supply of growing weeds. Those you catch in still ponds need seldom have a change of water; but the captives from rapid streams should have running water. See, too, that they are provided with their favourite hiding-places. Some like thick tufts of weeds; others prefer to hide in rocky holes, while several seek shelter under the stones of a rugged bottom. All such points as these may be easily settled by a careful observation of the fishes in their haunts. One more general observation: Give your pets their natural food when you can, but never more than is necessary. Flies, grubs, and worms are favourite dainties with nearly all; but, failing these, you may try fresh meat chopped very small, and an *occasional* sprinkling of flour paste. You must remember, however, that all excess of food will decompose in the water, rendering it putrid and poisonous.

Many of our fresh-water fishes belong to the Carp family (*Cyprinidæ*), and of these the Common Carp may be taken as a type. This fish (*Cyprinus carpio*) was once very rare in this country, and was probably introduced from the Continent. It attains a length of twelve or fifteen inches, and is exceedingly prolific, the number of eggs in a single roe numbering over half a million. It inhabits deep holes in the sluggish parts of our streams, and also thrives well in ponds. Its food consists of worms and insects, and, with these as bait, the carp is easily caught. In winter it lies concealed in the

mud at the bottom. This fish is very much desired for the aquarium and small ponds, especially as it can be easily tamed.

The Golden Carp, or Gold-fish (*Cyprinus auratus*), is apparently a universal favourite with aquarium-keepers. It was originally

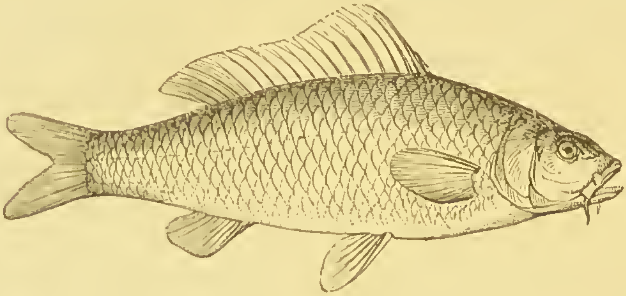

Fig. 42.—The Carp.

introduced from China, and has now become so far acclimatised that it does well in our ornamental waters.

The Minnow is deservedly a favourite, for it is not only one of our prettiest river fishes, but is hardy and easily tamed.

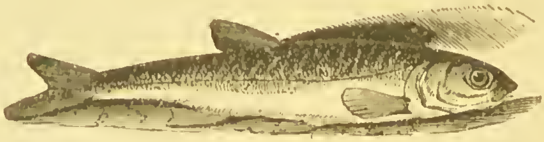

Fig. 43.—The Minnow.

Several other members of the carp family do well in captivity; but, unless your aquarium is a very large one, you must be satisfied with young specimens only. The Gudgeon, Roach, Dace, and Bleak

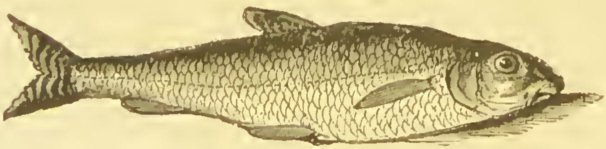

Fig. 44.—The Gudgeon.

are not difficult to manage, and their bright silvery scales will give a pleasing contrast to the other fishes.

The common Loach (*Cobitis barbatula*) does not seem to be so well known, nor have its interesting habits secured for it the popularity it deserves as an aquarium pet. A few years since I caught a few small loach in a stream at the southern end of Epping Forest.

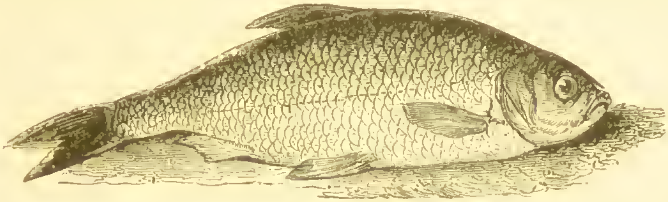

FIG. 45.—THE ROACH.

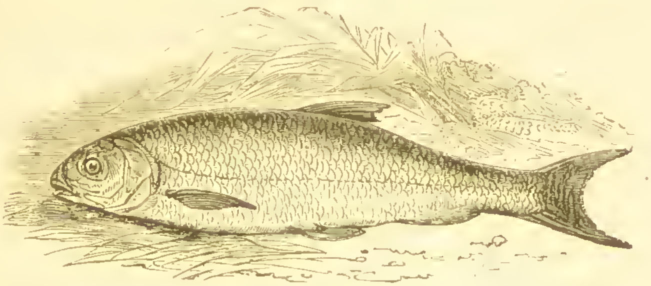

FIG. 46.—THE DACE.

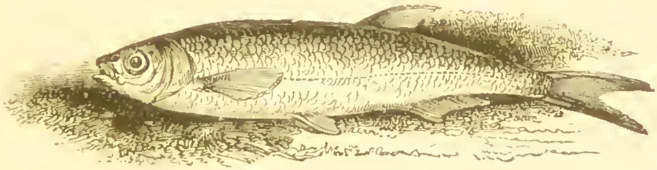

FIG. 47.—THE BLEAK.

FIG. 48.—THE LOACH.

These I placed in my aquarium and was greatly pleased with their movements. They are very heavy fish, and spend much of their time at rest on the bottom; but often would they rise to the surface, and, after dragging themselves on to the floating leaves of a water-lily,

somewhat after the manner of a seal when landing, they would bask in the hot sunshine with their bodies partly out of the water. In a very few days they became so tame that they readily took their food from the hand. The loach is a slimy fish, with six barbules at the mouth. It may be caught by dragging a strong net along the bottom.

Of all the British fresh-water fishes none is so interesting as the common Stickleback (*Gasterosteus aculeatus*), known popularly as the Tittlebat, Tittlebrat, or the Tittler. There are several species of sticklebacks, readily distinguished from each other by the number of spines in the dorsal fin. The term *gasterosteus* applied to all signifies bone-bellied, and is given on account of the bony bands which form a kind of coat of armour beneath. In addition to the spines of the back, there are the two formidable weapons of the breast (*pectoral*) fins, which, like the others, can be raised or depressed at pleasure. The commonest species has three spines on the back; another—a fresh-water fish—has ten; and a third, which inhabits salt water, no less than fifteen dorsal spines.

Sticklebacks are easily kept in an aquarium, but they are very pugnacious creatures, and must have plenty of space, or the 'survival of the fittest' will be demonstrated to perfection in a very short time.

Should you wish to closely observe the habits of these interesting creatures your best plan will be to secure one or two males, and a dozen or so females, early in March, and transfer them to a large glass aquarium, or, which is quite as good, a large tub. Give them a plentiful supply of gravel or sand, and introduce some pond weeds of any description.

During the greater part of the year the males and females are hardly to be distinguished from each other, both being of a dull greyish brown colour; but, as the breeding season approaches, the male gradually assumes the brilliant colours which have earned for him such names as 'Soldier' and 'Fiery.' His eyes then become bright green; the back also assumes a brilliant green colour, and the under-surface becomes bright red.

This change takes place in March or early April, and at this time the male stickleback sets busily about domestic affairs. His first work is to prepare a nest for the coming brood. In some cases this nest is composed entirely of vegetable fibres, which he has collected and woven into a kind of cylinder or barrel, open at both ends, and so short that, when occupied by the parent, both head and tail may be seen exposed. Sometimes, however, the nest is simply a hollow

scooped out in sand or mud, and covered over with interlacing vegetable fibres. Seeing that the stickleback has no building tool except his mouth, and no cement save the slime from his own body, we are bound to admit that great credit is due to him for the clever manner in which he prepares his snug little nursery.

The nest finished, his next business is to seek his mate. Having met with a suitable bride, he induces her to enter the nest, sometimes, it is said, even resorting to force when his affections meet with no encouragement. As soon as the female has deposited her eggs she is turned out of the nest, and the master immediately starts

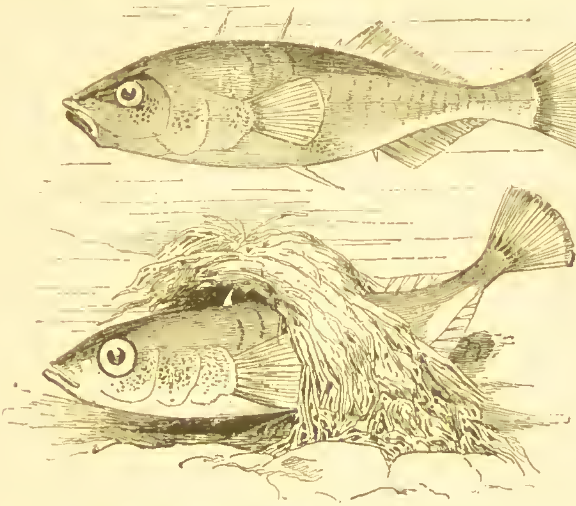

FIG. 49.—THE THREE-SPINED STICKLEBACK AND NEST.

in search of another mate, who is called in to take the place of the outcast. This is repeated till the male is satisfied that the supply of eggs is proportionate to the accommodation. He then closes the ends of the nest, and rigidly guards it till the eggs are hatched, and the young are strong enough to be allowed to roam into the world.

During the whole of this time the male 'tittler' will furiously charge all the creatures, including even the larger fishes of the pond or stream, who are so rash as to pass within a foot or so of the nest. But as soon as the young have gone to shift for themselves, and the duties of the nursery are thus brought to an end, he gradually loses much of his pugnacity, and at the same time his brilliant colours slowly fade away, to reappear in the following spring.

If you want to catch the Bullhead, known in parts as the Miller's

Thumb and the Tom Cull, you must look out for a shallow and rapid stream with a pebbly bed. Raise some of the larger pebbles, one by one, and at the same moment sweep your net rapidly towards it *against the stream.* In this way you may obtain several in a very

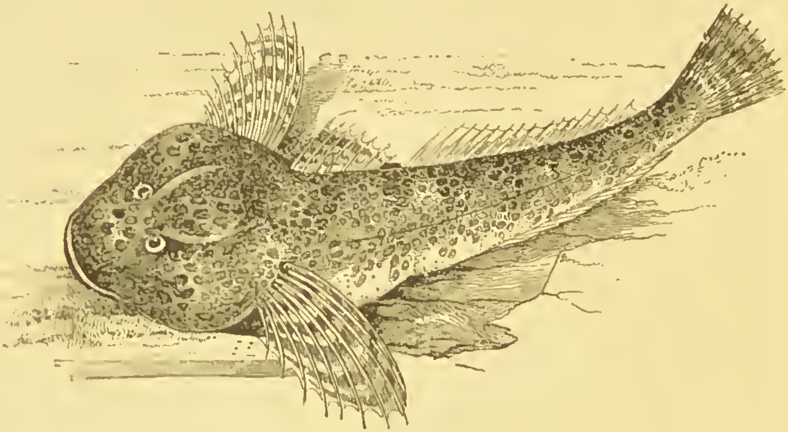

FIG. 50. THE BULLHEAD.

few minutes. You may keep these in your aquarium, but you will not see much of them, for nearly the whole of their time is spent in their hiding-places, and they seldom come out excepting when they make a dash at their prey, or shuffle their heavy bodies from one stone to another. Their food consists chiefly of insects and fresh-water shrimps.

AMPHIBIANS

We cannot take leave of our ponds and ditches without devoting a little of our space to the interesting *amphibious animals*—animals which, although not strictly aquatic, yet spend more or less of their existence in the water. These include the Newts or Efts, Frogs, and Toads.

Their life-history is as full of romance as is that of some insects. They begin life as little fish-like creatures, spending the whole of their infant period in the water, breathing by means of external fringe-like gills. In this stage they further resemble fishes in the possession of a two-chambered heart, and they also own a pair of air-sacs which correspond with the air-bladder of the fish. But as they advance in life a series of wonderful changes takes place, the fish-like form gradually developing into a creeping or jumping quadruped.

The external gills slowly disappear and give place to an internal pair hidden in clefts behind the head. But even these have only a transitory existence, for they soon vanish and pass their function over to a pair of true lungs which have been gradually evolved from the air-sacs above mentioned. At the same time other transformations have been progressing. The two-chambered heart has developed into a more complicated organ with three cavities; the limbs [1] have slowly made their appearance, first one pair, then another; and the original tail has, in some families, been slowly but entirely absorbed, while in others it has developed into a large, useful, and ornamental appendage.

The skeletons of the higher *Amphibians* are well developed, the build of the limbs in particular bearing a close resemblance to that of the highest animals. The ribs, however, are either very short or entirely absent.

The *Amphibians*, like fishes, are all cold-blooded animals, and the blood is remarkable for the comparatively large size of the cells (*corpuscles*) which it contains, those of the frog being one eight-

Fig. 51.—The Blood-cells of the Frog, highly magnified.

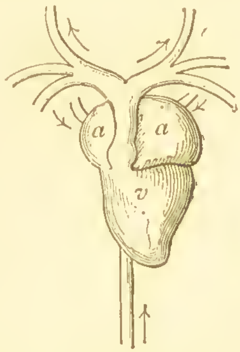

Fig. 52.—The Heart of the Frog.
a, auricles; *v*, ventricle.

hundredth part of an inch in diameter. Small as these bodies really are, yet they are large compared with the corresponding corpuscles in the blood of other animals. The circulation of the blood in the *Amphibian* may easily be traced. The upper portion of the heart consists of two chambers—the *auricles*. One of these receives the purified blood from the lungs, and the other the blood from all other parts. Both are continually forcing this into the

[1] Some of the lower amphibians are entirely limbless.

lower division—the *ventricle*—by a series of contractions or pulsations. The ventricle, in a similar manner, forces the blood through the whole circulatory system, some passing to the lungs for an additional air-supply, and the rest penetrating and bathing the other structures. Thus in each circulation only a *part* of the blood of the *Amphibian* is aërated.

We will now examine briefly the commonest of the British *Amphibians*—

Newts or Efts

There are but two common species of Newts in our country, and both these are more or less known by schoolboys, who speak of them generally as Effers or Effets. I have also frequently heard them called Lizards, especially when they have been seen wandering about on dry land. They are certainly much like lizards in general form, but may always be distinguished from these by the softness and colour of the skin. I have met with many who suppose that newts are never to be seen out of the water. But it is a fact that they spend much more of their existence out of water than they do in it. When on land, however, they always seek cool and shady places; while lizards delight to bask in the hot sun, spreading out their flattened bodies so as to expose a larger surface to his rays.

Strange tales have been and are still being told about the venomous and fiery character of newts. Some of our country folk aver that they can spit fire, even immediately on quitting the water; others tell horrible tales concerning the victims who have succumbed from the effects of their poisonous fangs; and, according to the accounts of others, many are the cattle that have been poisoned through drinking the water of ponds and troughs which were inhabited by newts. The country cottager who has lived out his threescore-and-ten in close proximity to a pond annually frequented by these dreaded *Amphibians* seems to be as ignorant about them as anyone; and on more than one occasion have such individuals looked at me with terror, and most earnestly entreated me to desist while I have been engaged in collecting newts; and the fear-stricken countenance has given place to an expression of wonder when, after careful watching, it was observed that the venom had had apparently no effect.

But, in spite of all that has been said, the newts remain, as ever, perfectly harmless and exceedingly pretty animals. They have no fangs and will not bite. Even if they did bite, they could not possibly do the slightest harm.

The Great Warty Newt (*Triton cristatus*) is a beautiful creature, sometimes attaining a length of over six inches. Its skin is covered with little wart-like projections, and is marked with a number of pores. The tail is flattened at the sides. The upper surface is of a varied dark brown; on the sides are rows of white dots, and silvery bands usually adorn the tail. But the chief beauty of the warty newt is the bright yellow under-surface, which is boldly patched with black. The female is rather larger than her mate, and the

FIG. 53.—THE GREAT WARTY NEWT.
Reduced in size.

latter has a beautiful waved crest along the back to the end of the tail. It is only during the breeding season, however, that the crest is to be seen in its fullest development; for it disappears slowly, but almost entirely, as this period closes and the summer approaches.

This newt hibernates during the winter months, and for the whole of this time the lungs are inactive, the creature deriving the small air-supply necessary for its indolent existence through its skin.

In March it takes to the water, and the best time to secure it for observation in the aquarium is towards the end of that month. Early in April the female *Cristatus* lays her eggs, depositing them singly on the leaves of water plants, and carefully covering up each one by rolling the leaf round it with its paws. The egg is globular,

and consists of a capsule, in which the white yelk floats in a colourless liquid. Outside the capsule is a covering of gelatinous substance, by which the egg is fixed to the leaf. In three or four weeks the young newt—known at this period as the *tadpole*—eats its way out of its prison, and starts life in perfect independence. In about three months the legs begin to appear—the fore pair first; but it is at least six months before the tadpole has completed all its metamorphoses.

In September all the newts, old and young, leave the water and seek a safe hiding-place in some snug hole or corner where several lie huddled together, occasionally straying abroad in suitable weather in search of food. The *young* newt does not return to the water till it is just three years old, at which age we may look upon it as having reached maturity; but it is not fully grown till the end of the fourth year.

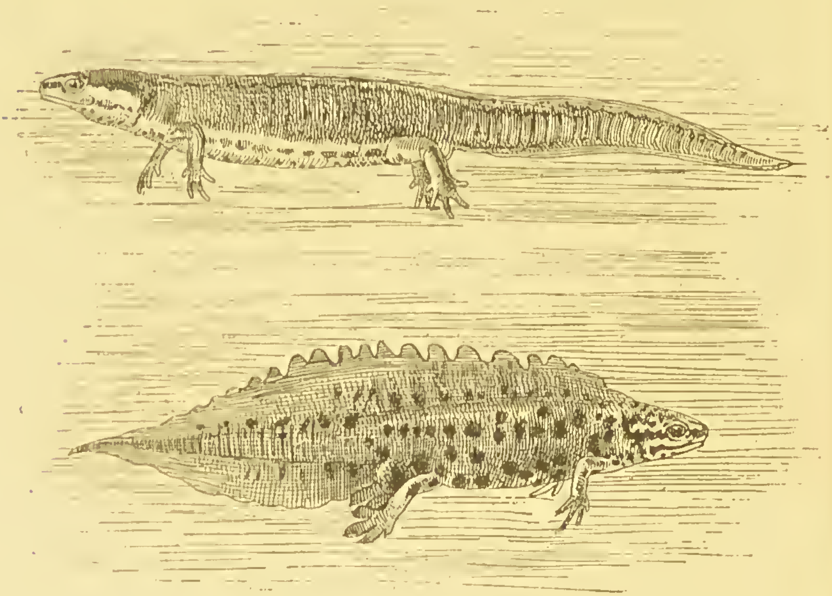

FIG. 54.—THE SMOOTH NEWT.

These creatures are very interesting in the aquarium, where they may be fed on worms; and they will not, as a rule, interfere with other inhabitants. It is necessary that they should be provided with a landing-place where they can find a shelter quite out of the water.

The common Smooth Newt (*Lophinus punctatus*) is much smaller than the last, seldom exceeding four inches in length. Its

skin is quite smooth. The colour of the male is light brownish-grey above, spotted irregularly with black; beneath it is light yellow, which changes to a brilliant orange, also spotted with black, in the breeding season. The male is crested at this time, and is then a beautiful creature. The female is only slightly spotted, and is not nearly so pretty as the male.

The growth and habits of this newt are very similar to those of

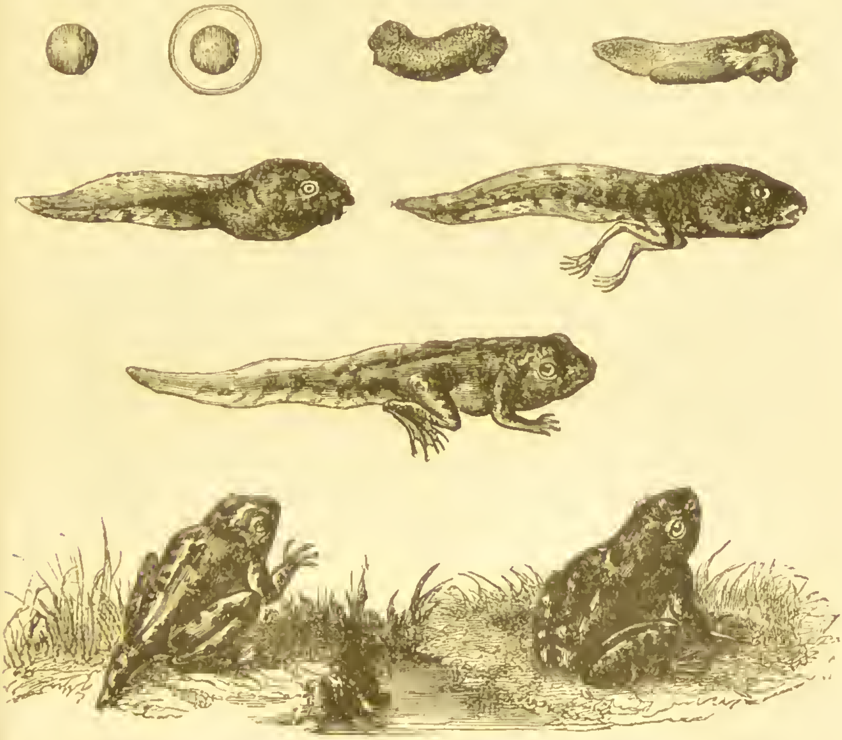

Fig. 55.—Stages in the Life of a Frog.

the last. Both species cast their skins at apparently irregular periods. It is very interesting to watch this operation. As a rule, the whole skin comes off in one piece, and the tiny gloves from off the feet are quite perfect in form, though as delicate as the finest gossamer. I have preserved a few of these cast skins in dilute spirit, and find them in excellent preservation after several years.

Frogs

Those who desire to watch the development of the Frog (*Rana temporaria*), and to observe its habits, should begin by collecting the eggs, which may be found in abundance in almost every pond. Early in the spring the frogs quit their winter quarters and make for the ponds, where they remain at rest during the day with

Fig. 56. The Common Frog.

heads just out of the water. During the night, however, they are full of activity, and the air resounds with their music.

About the middle of March the female deposits her eggs at the bottom of the pond. These are little black globular bodies, each surrounded by a covering of transparent gelatinous substance, the whole forming one irregular mass. The gelatinous envelopes soon swell up enormously by absorbing water, and then the mass rises to the surface, where it remains till the larvæ escape. In a few days

the black embryo elongates and gradually assumes a fish-like form, and may be seen moving about in the middle of its case. A few days more and the eggs are hatched.

The newly emerged tadpoles are very active little creatures of gregarious habits. They attach themselves to pond weeds by means of little suckers just beside their mouths, frequently changing their positions in the social gathering. At this stage they are vegetarians, feeding on confervæ and other low vegetable forms. As they gradually assume the adult form, they lose their gregarious tendencies, and swim about freely by means of the undulations of their flattened and fringed tails. In their subsequent metamorphoses they differ from newts in that the hind legs are the first to appear, and also in the gradual absorption and ultimate disappearance of the tail. On reaching the adult form they leave the water, and spend the remainder of the summer in the neighbourhood of the ponds, and feed entirely on insects, worms, and other small animals.

A few of the structural peculiarities of the frog are worthy of notice. A well-developed web extends between the five long and slender toes of the hind feet; but the fore feet, which have only four toes, are not webbed. The drums of the ears are conspicuous behind the eyes on each side. The tongue, which is often used to seize the smaller insects on which it feeds, is attached to the front of the mouth with its tip extending backward. The teeth are very small, and consist of a single row in the upper jaw and two small clusters on the roof of the mouth.

Fig. 57.—The Tongue of the Frog.

The breathing of the frog is performed exactly on the principle of a pair of bellows. At the nostrils are placed a pair of valves which open inward, and the contraction of the muscular floor of the mouth forces air into the lungs. Thus the frog may be choked by keeping its mouth open, for the air can no longer be forced into the lungs.

Toads

Many persons do not seem to know the difference between a toad and a frog, and thus it is we hear the name of one so commonly

applied to the other. Yet the distinguishing features of these amphibians are so obvious that the common error is almost inexcusable. The build of toads is very bulky and comparatively clumsy, and the dull-coloured skin, instead of being smooth and slimy, is drier and thickly covered with warts or pimples. The toads, moreover, do not leap like frogs, but walk slowly with a very awkward gait. The hind legs also are much shorter, and the hind feet only slightly webbed. They have no teeth either in the jaws or in the palate, and the gape of the mouth is much wider than in frogs.

Fig. 58. The Common Toad.

The metamorphoses of toads are very similar to those of the frog, but the eggs are generally laid a few weeks later, and are fastened together in long double chains, instead of in irregular masses. The tadpoles are also smaller than those of the frog.

Dreadful and wonderful tales are told and believed concerning this unfortunate creature. Its poisoned fangs, its venomous skin, its fire-spitting propensities, the magic virtue and curative power of the jewel in its head, and its enormous longevity are all accepted as indisputable facts, except by those who have kept and closely observed the toad, and thoroughly investigated into the alarming and startling reports. There is certainly some small sprinkling of

truth in the statements made concerning its venomous character, for its skin does certainly excrete an irritating fluid which is undoubtedly harmful to certain animals; but, while the toad is thus protected from the hungry jaws of animals to whom the frog is a luxurious morsel, the poison remains perfectly harmless to the human skin.

The Common Toad (*Bufo vulgaris*) is easily domesticated, and its habits—especially its mode of capturing and devouring its prey—are very interesting. Its partiality for all kinds of insects has long caused it to be regarded with favour by florists.

The Natterjack (*Bufo calamita*) is not nearly so widely distributed as *B. vulgaris*, but is rather common in certain localities. It may be known at once by the olive tint of its skin, and by the pale yellow stripe running down the middle of the back. It is also more active than its relative, and does not attain to the same large size.

Preservation of Aquatic Animals

It will now be desirable to dwell for a short time on the different methods of preserving our aquatic specimens, and on the arrangement of these into a useful collection for future study.

In many cases the real animal cannot be satisfactorily preserved, but some non-living portion of its structure, which may in itself be exceedingly instructive, and in many instances beautiful, can easily be kept permanently intact.

Soft animals, and soft parts of animals, may generally be preserved indefinitely in spirit of wine. But it must be remembered that this liquid has a great attraction for water; and, consequently, if the specimen be very soft and contain much water, the spirit will extract a quantity of the moisture, thus causing it to shrivel up till it is hardly recognisable.

Again, pure spirit is never necessary for mere preservation, being equally effective for this purpose when mixed with its own volume of water. My own plan is to keep a stock of small wide-mouthed bottles, fitted with good corks; also a supply of diluted spirit. It is then no trouble to bottle any specimen that is likely to prove useful in the future, either for a museum collection or for dissection. In this way one may soon get a useful collection of molluscs, crustaceans, fishes, amphibians, &c., always in good condition for examination when occasion requires.

All the winged insects caught in and about the water should find a place in the reader's collection. Instructions are given for killing

and 'setting' these in the part devoted to Insect Hunting. The water beetles in particular are well worth the trouble. Some of these may be 'set' with their wings folded as we generally see them, while others may have their wings expanded as in flying. Most of their larvæ are rather soft-bodied, and cannot be dried without losing their natural form. These are best preserved in diluted spirit, and stored in small bottles or specimen tubes.

See that every specimen is properly and fully labelled, and that it stands in its correct position with regard to the others. Each drawer or box should be marked outside with the name of the class or order to which its contents belong; and beneath each specimen should be placed a label containing its name, locality, date, and any other particulars considered sufficiently interesting.

How to prepare the Skeleton of a Frog

Among the various objects in a naturalist's museum, few, if any, will be more instructive than the collection of bones illustrating the comparative build of the various animal frameworks. But whence is such a collection to be obtained? There are several methods of preparing the skeletons of small animals, but all of them entail operations of a more or less tedious and disagreeable character. This, however, is nothing to the enthusiastic naturalist, who allows no trifle to stand between himself and his anticipated prize. But even those who have not sufficient enthusiasm to set them to work at bone-cleaning may still hope to acquire a moderate collection of useful specimens, which have already been prepared for them by the natural decomposition of the softer parts of dead animals, aided by the industry of nature's scavengers—the insects.

I have many useful specimens, some of them complete skeletons in good condition, which have been simply picked up from the spots where their former owners died.

But the naturalist does not restrict himself to this haphazard means of collecting his bones. He aims at obtaining a good *typical* collection, as far as his means and his leisure allow, and finds it useful to know how to set to work to obtain a complete skeleton, in good condition, of any small animal.

We will now see how this is to be done in the case of the frog, reminding the reader that the instructions given will apply almost equally well to all the vertebrate animals of our ponds and streams.

First kill the frog, if alive, by shutting it in a vessel with a piece of blotting-paper that has been moistened with a few drops of

chloroform, and then lay it out on a board. With a sharp knife in the right hand, and a pair of forceps in the left, cut away the skin and abdominal walls, and remove all the internal organs, being very careful not to injure any of the bones or cartilages.

After the body-cavity has been cleared of its contents, the muscles of the trunk and limbs may be attacked in a similar manner; but the white ligaments that bind the bones together at the joints must not be cut.

When the skeleton has been roughly cleaned in this way it may be put aside out of doors, in a dish of water, in some spot where the unpleasant odours arising from the decomposition of the little animal matter that remains can give no offence.

Fig. 59.—Skeleton of the Frog.

At intervals of a few days a gentle stream of water should be allowed to play upon it, to remove any refuse, and loose pieces of the perishable matter should be removed with the forceps or a soft brush. When, at last, everything has decomposed with the exception of the bones, the cartilages, and the ligaments, the skeleton may be gently removed from the water, set in some natural position, and then allowed to dry. When quite dry, any of the parts which may have become detached from the general framework may be fastened in their proper places with a little glue or cement.

CHAPTER II

INSECTS AND INSECT HUNTING

Many of our insects have already been alluded to, but up to the present we have confined our attention to the resident population and the frequenters of our ponds and streams. We must now see what can be done in other quarters; so for a time we quit the miry banks and odorous mud, and wander through lanes and woods, and try our luck in meadows and waste places. Our work now is strictly entomological—that is, confined entirely to the insect world. So we will set to work till we have put together all the necessary paraphernalia, and then start off delighted with the thought that we have at last been metamorphosed into real live entomologists.

The entomologist has a happy time of it, for there is no doubt that he has selected for his study some of the most beautiful of all animated beings; and he is continually finding something that is entirely new to him.

Some insects are said to be positively ugly; others we regard as extremely noxious to our persons; others, again, earn our enmity for their extensive damages to our crops. But we must put aside all such prejudices, if we would make ourselves acquainted with the wonderful habits and marvellous structures and metamorphoses of the chief divisions of the insect world.

A true entomologist finds delight in the study of *all* insects. None are too small to attract his attention. If the naked eye fails to detect any beauty of form or colour, he knows that his lens will at once change the appearance. He is not content to study the creatures of the air, but searches diligently for the creeping inhabitants of the earth, turning them out of all kinds of chinks and crannies, and digging them out from their homes in the soil.

We will now proceed to study a few of the most popular orders.

Scaly-winged Insects

We shall first take the *Lepidoptera*, or scaly-winged insects, by far the most beautiful of all the insect world, and the favourites of all entomologists. The four wings which constitute the chief beauty of the perfect insects of this group are more or less covered with little scales of exquisite form, and generally exhibit a wonderful variety of colour. Everyone has observed the mealy dust which is so easily removed from the wings of Butterflies and Moths when these creatures are handled. These dust particles are the scales

Fig. 60.—Scales from the Wings of Butterflies.

which form the characteristic feature of the *Lepidoptera*, and it is only necessary to collect a little of this on a slip of glass, and examine it under a microscope, to satisfy oneself as to the extreme beauty of the wings. The head is furnished with a pair of antennæ, which are undoubtedly connected with one or more of the senses of the insect. There is also a very delicate proboscis, or sucker, by means of which the sweet juices of flowers are imbibed. This can be rolled up into a spiral when not in use. The structure of this organ is really a wonder, for, although it is about as fine as a hair, yet it consists of two separate pieces, each one finely grooved, and the two are locked together from end to end by means of a fringe of

minute hairs so as to form an air-tight tube. The eyes are large and rounded, and looking almost all ways at the same time; and the number of lenses sometimes amounts to nearly two thousand in a single eye. In addition to these compound eyes there are two simple eyes or *ocelli* situated on the top of the head, but these are generally so thickly covered with down that they probably have but little to do with vision.

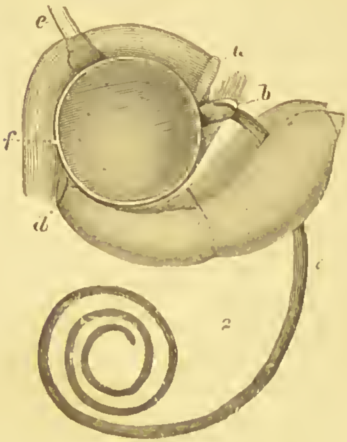

FIG. 61. HEAD OF A MOTH.

a, upper lip; *b*, mandibles; *c*, proboscis; *d*, under lip; *e*, antennæ; *f*, eye.

The sole work of the perfect butterfly and moth is the reproduction of their kind. The females always lay their eggs on the food-plants of the larvæ, and it is astonishing with what precision the proper vegetation is selected in preference to all others. We could understand this habit of the maternal parent if she herself derived any direct benefit from the same plant as that which sustains her offspring; but it generally happens that none of the sweets of her life are to be obtained from the food-plants she so carefully selects, and she cannot possibly settle on them except for the one special purpose of providing for her progeny. Very soon after this work is accomplished the parent dies, and this generally before the eggs are hatched.

The eggs of butterflies and moths are beautiful objects for the microscope; and, as they require no special preparation of any kind, the least expert microscopist is not denied the opportunity of witnessing their beautifully sculptured forms and delicate tints. During the summer months a great variety of eggs may be obtained by searching the leaves in our gardens, and these may be examined *in situ* as opaque objects, throwing a good light on them from above. The time which elapses before the appearance of the larvæ varies according to the time of the year. Eggs laid in spring take longer to hatch than those laid during the summer months, and those laid in the fall of the year do not hatch till the following spring.

When the time arrives for the appearance of the young larvæ, they gnaw their way out of the shell, and sometimes even devour

entirely the little case from which they emerge. They are now surrounded by abundance of food, and right well do they make use of it, for they often eat as much as three times their own weight of food during the first twenty-four hours of their existence, and continue to live after this riotous fashion during the weeks or months of the larval life. In this state they undergo several moultings, for they grow so fast that their old coats become tight and uncomfortable. When about to cast its skin, a larva will cease eating for a time, and seek out some secluded spot until its little trouble is over. At last the tightened skin splits and begins to peel off, and the larva, after many twitchings and twirlings of its uncomfortable body, manages to creep out of its old garment, and to show itself in its new and often differently coloured suit. The body of the larva or caterpillar consists of thirteen segments, including the head. Three pairs of legs are appended to the second, third, and fourth segments, and a variable number of claspers to the hinder joints, usually making up a total of sixteen limbs. Many of them are furnished with a silk-spinning apparatus which is attached to the lower lip.

The period during which the *Lepidoptera* remain in the pupal condition varies considerably. In some cases this is a few days only, but in others the time extends over several months, including perhaps the whole of the winter and spring. The pupa is sometimes naked and hidden in the earth; sometimes concealed in a cocoon of earth, silk, moss, chipped bark, or fragments of mortar from an old wall; some are suspended by the tail, and secured by a silk cord round the middle; and others are rolled up in leaves and well secured from their enemies by numerous silk bands or fibres. In the pupal state life sometimes seems quite dormant, and the length of time thus spent seems to depend entirely on the temperature. Thus the emergence of the perfect insect may be delayed for months or even years by prolonged exposure to cold, or may be hastened by placing the pupa in a warm situation.

One of the most interesting sights ever witnessed by a naturalist is the gradual unfolding and developing of the wings of a newly emerged butterfly or moth. Shortly before this event takes place the tint of the chrysalis is seen to change, the colour of the wings and body often showing itself through the half-transparent case. At last the thin shell breaks, and the perfected insect returns to the world in which it spent its early life as a crawling grub. It is soon free from its prison cell, and immediately seeks some rising surface, up which it creeps. Here, if possible, it selects the under-side of

some branch or ledge, and fixes itself with its back downwards to dry its body and expand its wings. At first it is a queer-looking creature, its wings short and dumpy, more like a pair of useless excrescences than the richly ornamented pinions into which they are soon to develop. As we watch the insect closely we observe the wings expand irregularly till they present quite a crumpled appearance. At last they straighten themselves out till they have reached their full size. The insect, however, remains stationary, for the newly developed wings, the nervures of which are just filled with currents of fluid from the body, are very moist, and so soft and flexible that they bend back on the body if the insect turns over. But after a few hours the wings are dry and rigid, and after sundry flutterings, as if to test the mechanism of the new flying apparatus, the insect starts its aërial life.

FIG. 62.—MOTH JUST EMERGED.

Very few persons, excepting those who delight in the appellation 'Entomologist,' know the difference between a butterfly and a moth. Some appear to base their distinction on the brilliancy of the plumage of the wings; but, since many of the moths are adorned with gaudy colours while some of the butterflies are positively dingy, we must consider them quite wrong in their nomenclature. Others have the idea that the nocturnal habits of the moths are sufficient as a distinguishing characteristic, not knowing that several species of these insects delight in the midday sun. It is true that the butterflies are *generally* more brightly coloured than moths; also that *all* the butterflies are day flyers, while *most of* the moths are nocturnal; but there is one distinguishing mark which can never lead us astray: the antennæ of all butterflies terminate in little knobs or 'clubs,' while those of the other *Lepidoptera* taper to a point. There are yet other differences which, although not to be taken as absolute, are of sufficient interest to note. Butterflies, when at rest, usually raise their wings perpendicularly, pressing them together over their backs; but moths either spread out their wings horizontally, or bring them close over their bodies, often folding the hinder pair quite out of sight beneath the fore wings. Again, moths generally curve their antennæ backward under the head and thorax —a feat which is impossible with the rigid horns of butterflies.

Catching Butterflies

The apparatus required for this part of the entomologist's work is simple and small in amount. A net, a killing bottle, a collecting box, and a supply of pins of various sizes are all that are required.

The net should be of gauze, preferably of a green colour, about twelve or fifteen inches in diameter, with a light but strong frame.

As a general rule the entomologist does not require to keep many of his insects alive, and consequently finds it convenient to take with him some arrangement with which he can perform the 'happy despatch.' This is, to my mind, the only unpleasant part of his work. And even though some authorities give it as their opinion that insects cannot feel pain, yet we should always act as if we were sure they could, and kill the insects required, and no more, in the most humane manner possible.

There are many methods of killing insects, each method having its devoted advocates; so I cannot do better than mention a few of those most commonly used, leaving the reader to try any or all of them, and so be in a position to decide on a plan that suits himself. At the same time, having given all the methods here mentioned a very fair trial myself, I will give my own experiences, and my opinions as to their relative value in my hands.

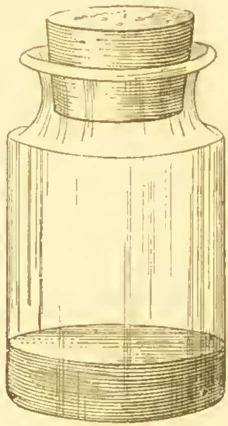

Fig. 63.—The Cyanide Bottle.

The first I will mention is the 'cyanide bottle.' This is simply an ordinary wide-mouthed bottle, such as is used to contain pomades and other similar luxuries, not less than four or five inches in height, into which is put some potassium cyanide with an absorbent material. The cyanide bottle may be purchased of the 'naturalist' ready for use, or it may be easily fitted up by anyone. The potassium cyanide may be bought at the chemist's, providing he knows you and is satisfied as to your intentions; but it is a deadly poison, and must be used with considerable caution. Dissolve a few drams of the 'cyanide' in a little water, and add slowly, with constant stirring, sufficient plaster of Paris to convert it into a thin paste. Pour this at once into the bottle

and leave it to 'set.' Close the bottle with a good cork, and it is then ready for use. A cyanide bottle prepared in this manner will retain its power for a great length of time if kept tightly corked. Some entomologists dispense with the plaster, and put a few pieces of the cyanide into the bottle, keeping them in place with a few thicknesses of blotting-paper cut to the proper size. This, I think, is not nearly so good a plan, for the paper and cyanide are easily shaken out of their position, and may then seriously damage the insects.

Chloroform, benzole, and ammonia are often used for killing insects. In either case a few drops of the liquid should be thrown on to some absorbent material in the bottom of the bottle just before it is required for use; but it should not be used in such quantity as to *wet* the insects, especially if ammonia is chosen, for this liquid will injure the colour of many specimens and completely spoil them. Both chloroform and benzole, and especially the latter, render the insects very rigid, so that there may be some difficulty in 'setting' them after. The fumes of burning sulphur have also been employed, but I denounce this at once as troublesome and inconvenient, and because it so often results in damaged specimens.

The 'laurel bottle' or 'laurel box' has many decided advantages. Some young laurel leaves are well beaten with a hammer, wrapped up and tied in a piece of calico or strong muslin, and then pressed firmly into the bottom of a wide-mouthed bottle or a cylindrical tin box. It should be pressed in so firmly that there is no chance of its falling out of its place; and should fit close round the sides of the bottle to prevent insects from being jammed between it and the glass. I have made a very useful laurel *box* as follows: Procure two cylindrical tin boxes of exactly the same size—four or five inches high and about two in width answers admirably. One is required only for its lid. Knock or cut out the bottom of one box. Make a false bottom of perforated wood, and fix it in this, about one-third from one end, and then put the two lids, one on each end. The smaller division is to contain the bruised laurel leaves, and the larger is for the insects. The laurel is very quick in its action, but should always be used fresh. It will keep the insects in a moist or 'relaxed' con-

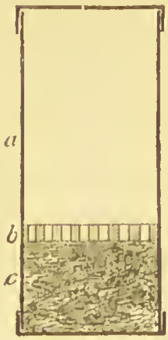

FIG. 64.—THE LAUREL BOX.

a, space for insects; *b*, perforated partition; *c*, bruised laurel leaves.

dition, so that they are easily set, either on the same day or a few days after the capture.

The box just described may be used for the other stupefying agents as well as the laurel. Thus the smaller division may contain some cyanide wrapped up in blotting-paper or linen rag, or it may be filled loosely with cotton-wool or any absorbent to which either of the liquid agents may be applied. In fact, this is altogether a very convenient arrangement, for the 'charge' can be renewed at any time, even when the insects are in the other division, and without disturbing them much. It must be remembered that the liquid poisons—chloroform, benzole, and ammonia—are volatile; and, as a consequence, some is lost in the form of vapour each time the box is opened. Hence it is advisable, when using either of these, to take a small bottle of it in the waistcoat pocket for recharging.

Care must always be taken to leave the insects in the killing bottle or box until quite dead. We cannot easily tell when that is, for they are stupefied and rendered quite motionless before death takes place; and if removed too soon they will often revive.

Butterflies are so delicate that it is not safe to allow them to remain in the killing box very long, to be trampled on and turned over by their new arrivals; nor is it well to leave them loose in boxes of any kind, for their wings are easily damaged if they are shaken about. They should be pinned as soon as dead. For this purpose the collector will require a 'collecting box' and some entomological pins of various sizes.

The former should be as large as can be conveniently carried in the pocket. It should be either oval in form, or oblong with rounded corners. As most of the insects, and possibly all of them, will be taken home in this, it will be advisable to have the box so constructed that they cannot become dry in it. For this reason it should be of tin or zinc, the cover fitting closely, but opening easily by a hinge or hinges. The box should be so deep as to allow the butterflies to be pinned to both the top and the bottom, which should be lined with cork. Just before starting on the collecting expedition the cork should be saturated with warm water, or a piece of damp sponge pinned firmly in one end, as a further precaution against rigidity.

The pins used by entomologists are very fine, with small heads. They are sold at the 'naturalists' shops,' and may always be obtained through the post.

A great deal depends on the choice of the day for a butterfly

hunt. A bright warm day is essential; and it should be known that these insects will never expose themselves to an east or north-east wind. The best time of day for actual work is between the hours of eleven and four; and the best localities are flowery meadows—especially the borders, lanes, chalky districts, flowery railway-banks exposed to the full sun, clover fields, borders of woods, and flowery wastes. It must be observed that many butterflies are very 'local.' Hence if we are in search of any of these, it is necessary to make ourselves acquainted with their haunts. It would not be advisable to dwell on this subject now, but some of the chief peculiarities of many species will be mentioned presently.

Having at last reached our hunting-ground, how are we to proceed? We all remember the time when a butterfly, white or purple it mattered not, was a certain stimulus resulting in the violent action of the muscles of every limb. It was the signal for a chase, and the contest between ourselves and the insect was always one of speed and endurance. And then, if successful in bringing down the winged creature with the cap, or, it may be, the coat, with what pride did we pin the insect to adorn the very weapon by which it was laid low! But now our captives are to form a permanent and useful collection. They must necessarily be caught without injury to their appearance, handled with the greatest of care, and killed in the most humane manner possible. We therefore relinquish the cap for the net; and learning by experience that the butterfly on the wing is sometimes more than a match for our legs, we resort to stratagem. As a rule it is not advisable to start off at full speed immediately on seeing the insect, but follow it up gently, keeping some distance behind, giving the creature every opportunity of alighting on its favourite plant or flower, and then a few cautious steps and a sharp stroke of the net will generally settle the business. Sometimes, however, a butterfly shows at once by its almost straight and unhesitating movement to be intent on a long flight. In such a case, should you desire it, you must make up your mind for a good run, with one eye on the insect, and the other on the look-out for ditches, mole-hills, and furze clusters.

The insect is sure to flutter a great deal in the net, and no attempt should ever be made to handle it until it is quiet. If a killing bottle is to be used, this might be passed at once into the net by the left hand, and the bottle covered quickly by the right as soon as the insect is secured. If this plan is adopted, we soon find a number of captures in the bottle; and, as we are still actively on

the chase for more, we are liable to injure these by causing them to rub together as we run. To avoid any damage in this way the butterflies should be pinned in the collecting box as soon as we are satisfied that they are quite dead. Some collectors dispense with the killing bottle for butterflies altogether. They wait till the insect can be secured in the net, with its wings closed over its body, and, gently pressing the folds of the net against it from the outside, kill it instantly by nipping the *thorax* between the finger and thumb. Of course this must be done with the greatest of care, or the insect may be so damaged as to be perfectly useless. One objection to this mode of procedure is that the insect may only be temporarily quieted; so that, when we open the collecting box for a future specimen, we are horrified at the sight of our pinned butterfly struggling to escape.

Setting and arranging the Butterflies

Our butterflies must now be 'set' for the cabinet. This need not be done at once—in fact, it may be postponed for many days or weeks—but it is always advisable to set them as soon as possible. If they are in a metal collecting box, their limbs will remain soft and pliable for some days; but they should not be kept in a moist condition for a great length of time, or you will find them completely covered with a forest of mildew.

It is of no use attempting to set an insect after its limbs have become dry and brittle, for under these circumstances the slightest pressure will cause a part to snap off. The insect must first be 'relaxed.' To do this it is simply necessary to pin it for a day or two in a metal box containing a damp sponge or moistened blotting paper, or to keep it for a corresponding time under a tumbler or other vessel with some means for keeping the inclosed air moist. A very simple plan is to fix the pinned insect to a cork, float it on a little water in a saucer, and then cover it with an inverted tumbler.

The dealers sell 'relaxing boxes' for bringing about the same result. These are zinc boxes lined with cork and covered with a well-fitting lid. The cork is kept in position by means of small projecting pieces of metal in preference to any kind of glue or cement, as the latter would not stand the perennial dampness. The cork may be moistened with a little water, or a piece of damp sponge may be pinned inside, and the box is then ready for the

insects. The specimens brought home in a wood collecting box are often so dry that they cannot be set even on the same day; but if a metal box be used there will be no need for the relaxer, for they will keep in a good pliable condition for several days.

If an insect, when set, does not give satisfaction, it may at any future time be relaxed and reset; and collectors often find it convenient, when away from home for some time, to keep all their captures in the collecting boxes till they return, and then set them at their leisure, relaxing them in batches as required. This avoids the necessity of taking away the 'setting boards' and store boxes. Space, too, is a matter of great consideration, and insects usually pack away in a much smaller compass before than after setting.

When engaged in setting our specimens we must always avoid the direct use of the fingers. The best way to get the various parts into their proper positions is by the use of a needle mounted in a small wood handle. A few of these 'setting needles' should always be kept handy. They are easily made by cutting little pieces of twigs, and then pushing the heads of ordinary sewing-needles into them. They may be of different sizes to suit the various degrees of delicacy required in the manipulation.

'Setting boards' are now required. These are usually constructed as shown in section in fig. 65. A piece of soft deal, free from knots, and about a quarter or an eighth of an inch thick, is cut into strips about eight or ten inches long, and varying in width from one and a half to five inches. These slips are covered with cork, glued on, and then grooved down the centre to receive the bodies of the insects. Lastly, the surface of the cork on which the wings are to be laid is covered with clean white paper. Such boards may be obtained at the dealers'; but, if expense is a consideration, seeing that several will be required, they may be made in a very economical manner. The cork bed may consist entirely of sliced wine-corks, cut clean with a sharp knife, and then glued to the wood quite close together.

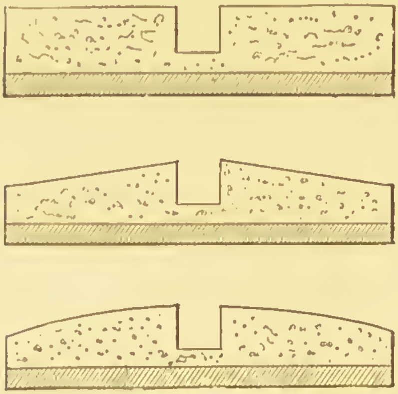

Fig. 65.—Sections of three kinds of Setting Boards.

Or cork may be dispensed with altogether if good wood, uniformly soft, is procured. In this case it is simply necessary to cut a groove with a gouge, and bevel off the edges with a plane, if necessary; or, I might say, if it suits the fancy of the collector. There is a great difference of opinion with regard to this. Some prefer a rounded board, some a plain bevel on each side, and others a perfectly flat surface. For my part I reject the round board, since I have never yet seen a live butterfly with wings bent into a curve. Whatever form be adopted, all the boards should be of the same pattern, so that there may be a degree of uniformity in the cabinet.

The setting is done as follows: First see that the pin is passed *centrally* through the thorax. If not satisfactory, it should be removed and reinserted, passing it through till the point is projecting quite one-eighth of an inch on the under side. Now fix the pin in the centre of the groove of the setting-board *perpendicularly*. Spread out the wings with a setting needle, being careful not to touch the upper surfaces, and then secure them by means of little strips of rather stiff paper as shown in the accompanying cuts. Some of the butterflies, at least one of each species, should be set on their backs, so as to show the under surfaces of the wings and other distinguishing characters of the under surface of the body as they lie in the cabinet.

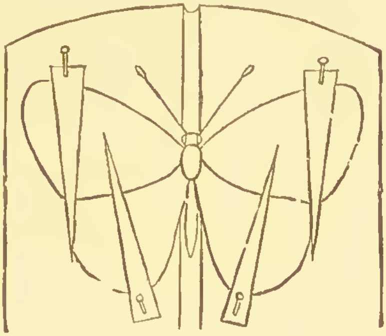

Fig. 66.—A Butterfly on the Setting Board.

As a rule four of each kind is sufficient for all purposes: two of the male and two of the female, one of each exhibiting the upper, and one the lower, surface. In some cases, however, the species is so variable that it will be interesting to introduce a few others simply to illustrate the varieties.

And now we come to one of the chief difficulties which the young collector has to experience. Where shall we keep all our specimens? The boy who is clever with his tools does not hesitate long over this matter, but sets to work at his cabinet or his boxes; and I can personally declare what a pleasure is to be derived from putting

together a storehouse to be adorned with some of the most beautiful of Nature's works. And what a delight to behold it when it is finished and occupied! How often does he make an excuse to cast another eager glance at his prize! First he admires the outside. Then the compartments are opened in turn, each creating fresh delights. And this routine is gone over and over again with undiminished interest, for the work is never complete. New specimens are continually being added to the collection, each one bringing with it fresh beauties, and another item to the small knowledge gained of Nature's works.

Now as to the form which the storehouse shall take. Some prefer the cabinet because it forms a sightly article of furniture; but, when one has to purchase it at the cost of a guinea per drawer, another question has to be considered. If you are fortunately able to make one for yourself, then pay attention to the following points: Use well-seasoned wood, avoiding cedar on account of its resinous character. Let the drawers be as nearly as possible air-tight, and each covered with a well-fitting glass. Cover the bottom of the drawers with cork, and on this fix some pure white paper with thin paste.

Some entomologists prefer store boxes to cabinets. They are certainly far more portable; and if placed on shelves, standing on end like books, they do not collect much dust. They are preferably made in book form, and lined with cork on both sides.

It is absolutely necessary to take some precaution to prevent the intrusion of mites, otherwise the insects will be devoured. For this purpose some camphor or naphthaline must be placed in every drawer or box, and renewed as occasion requires.

In conclusion I may say that well-made cabinets and store boxes are not by any means a necessity to the young collector. Any well-fitting drawers or boxes may be used to contain insects; and if cork lining proves to be a too expensive article, they may be covered inside with sliced wine corks, or with a piece of good soft 'cork carpet,' remnants of which may be sometimes obtained at a low cost from the furnishing warehouses. Always arrange the insects in perpendicular rows, and in scientific order; placing the name of the order at the top of each row, and the name of the insect under each species. The names of the families and sub-families also, where known, should be fixed at the head of the groups. Complete label lists are to be obtained at the various dealers', or the names may be neatly written on very small pieces of thin card, and then pinned in their proper positions.

British Species

Our British butterflies number only about sixty species; and since these insects have always proved such an attraction to naturalists generally, and to *young* collectors in particular, I have thought it desirable to introduce them *all* to my readers. Many of them, however, are either very rare, or are to be found only in certain localities; so that one cannot possibly have the pleasure of seeing all these beautiful insects on the wing without spending a great deal of time and money in visiting their various habitats at the proper seasons. And yet every collector is proud to possess a complete cabinet of our British butterflies, especially if all the specimens have been caught by himself. If the collection cannot be completed by captures in the field, the blanks in the cabinet should be filled up as far as possible by the rearing of species at home. The eggs and the larvæ may be obtained from the dealers; and much pleasure may be gained in watching the development and metamorphoses of the home-bred pets. But sometimes there is much difficulty in securing the proper food-plants, so that successful breeding becomes almost an impossibility. In this case, rather than have a permanent blank, purchase the pupa in preference to the perfect insect; for it is certainly better to become acquainted with two stages of the life-history than to see the lifeless imago only.

The following is a classified list of British butterflies, useful as showing how they may be scientifically arranged in the cabinet or in the store boxes:

Family **PAPILIONIDÆ**:

Papilio Machaon	The Swallow-tail.
,, Podalirius	Scarce Swallow-tail.

Family **PIERIDÆ**:

Pieris Brassicæ	Large Garden White.
,, Rapæ	Small Garden White.
,, Napi	Green-veined White.
,, Daplidiee	Bath White.
Gonepteryx Rhamni	Brimstone.
Colias Edusa	Clouded Yellow.
,, **Hyale**	Clouded Sulphur.
Aporia Cratægi	Black-veined White.
Euchloe Cardamines	Orange Tip.
Leucophasia Sinapis	Wood White.

Family **VANESSIDÆ**:

Vanessa Cardui	Painted Lady.
,, Atalanta	Red Admiral.
,, Io	Peacock.
,, Antiopa	Camberwell Beauty.
,, Polychloros	Large Tortoiseshell.
,, Urticæ	Small Tortoiseshell.
,, C. Album	Comma.
Limenitis Sybilla	White Admiral.
Apatura Iris	Purple Emperor.
Argynnis Paphia	Silver-washed Fritillary.
,, Aglaia	Dark Green Fritillary.
,, Adippe	High Brown Fritillary.
,, Lathonia	Queen of Spain Fritillary.
,, Euphrosyne	Pearl-bordered Fritillary.
,, Selene	Small Pearl-bordered Fritillary.
Melitæa Cinxia	Glanville Fritillary.
,, Athalia	Pearl-bordered Likeness Fritillary.
,, Artemis	Greasy Fritillary.
Nemeobius Lucina	Duke of Burgundy Fritillary.

Family **SATYRIDÆ**:

Arge Galathea	Marbled White.
Lasiommata Egeria	Speckled Wood.
,, Megæra	Wall.
Hipparchia Semele	Grayling.
,, Janira	Meadow Brown.
,, Tithonus	Large Heath or Small Brown.
,, Hyperanthus	Ringlet.
Erebia Blandina	Scotch Argus.
,, Cassiope (Epiphron)	Mountain Ringlet.
Cænonympha Davus	Marsh Ringlet.
,, Pamphilus	Small Heath.

Family **LYCÆNIDÆ**:

Thecla Betulæ	Brown Hair-streak.
,, Pruni	Black Hair-streak.
,, W. Album	White Letter Hair-streak.
,, Quercus	Purple Hair-streak.
,, Rubi	Green Hair-streak.
Chrysophanus Phlæas	Small Copper.
,, Dispar	Large Copper.

Polyommatus Argiolus	Azure Blue.
,, Alsus	Bedford Blue.
,, Aeis	Mazarine Blue.
,, Arion	Large Blue.
,, Corydon	Chalk Hill Blue.
,, Adonis	Clifden Blue.
,, Alexis	Common Blue.
,, Ægon	Silver-studded Blue.
,, Agestis	Brown Argus.
,, Artaxerxes	Artaxerxes.

Family **HESPERIDÆ**:

Pamphila Actæon	Lulworth Skipper.
,, Linea	Small Skipper.
,, Lineola	The New Small Skipper.
,, Sylvanus	Large Skipper.
,, Comma	Silver-spotted Skipper.
Pyrgus Alveolus	Grizzled Skipper.
Nisionades Tages	Dingy Skipper.
Steropes Paniseus	Chequered Skipper.

The above list contains sixty-seven species; but one of them—the Scarce Swallow-tail—has been so seldom seen in this country that we can hardly regard it as our own. And another—the Large Copper Butterfly—has not been seen for many years, and is probably now quite extinct. It will be noticed that each butterfly possesses two Latin names in addition to its popular English title. The first of these, printed in heavier type, is the name of the *genus* (a subdivision of the family) to which it belongs. Entomologists usually prefer the Latin to the English names; and there is one decided advantage in this, for, as the insects are known by these names to all naturalists, both at home and abroad, it enables one to converse freely on butterfly topics with all entomologists whom we may meet. It is common, however, to make use of the latter or *specific* name only; this being quite sufficient to distinguish the particular species. Thus, we should speak of the Large Garden White as *Brassicæ*; and the Common Blue as *Alexis*; and so on. If, then, the collector has no special repugnance to the Latin tongue, he is advised to make himself acquainted with these names.

We must now examine the British butterflies, observing briefly their appearance, their habitats, and a few other points of interest.

The Swallow-tails

The Swallow-tail Butterfly (Plate II) may be distinguished from all the other British species by the 'tails' of the hind wings which give to the fly its popular name. Its wings are of a rich and deep cream colour, marked boldly with patches of velvety black; and a reddish-brown spot marks the inner angle of the hind pair. It is unfortunate that the range of this beautiful insect is so limited. Those who want to see it on the wing must needs go to the fenny

Fig. 67.—The Scarce Swallow-tail.

districts of Norfolk, Cambridgeshire, and Huntingdonshire, for it is seldom met with elsewhere; and I would strongly recommend those who are unable to visit its habitat to purchase the insect in one of its earlier stages, and so have an opportunity of watching its development.

We cannot *now* claim the Scarce Swallow-tail as one of our own butterflies; but since it *has* been caught on our island, and is too fine an insect to be entirely forgotten, I figure it here. It is still

common on the other side of the Channel, and specimens are consequently easily obtained at a low cost.

The 'Whites'

We shall include under this head all the members of the family *Pieridæ.* Three of them—the Large, the Small, and the Green-veined—are very abundant, and they are also so similar in appearance that they are one and the same insect to the young urchins who may be seen *everywhere*, cap in hand, doing their level best to wipe them off the face of the globe. To these 'insect hunters' a *Small* White is a *young* Large White, and the green veins on the under surface of the 'Green-*veined*' entirely escape their imperfect observation. The larvæ of these three 'whites' are to be found in

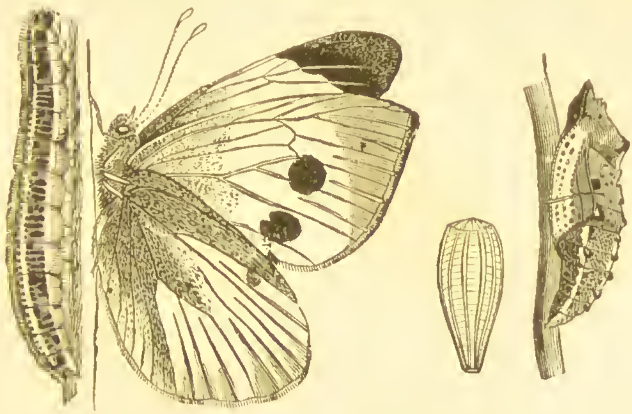

FIG. 68.—THE LARGE WHITE. EGG (MAGNIFIED), LARVA, PUPA, AND IMAGO.

abundance in all kitchen gardens, sometimes eating their way into the very hearts of cabbages; and were it not for the ravages of the ichneumon flies and small birds *we* should soon be butterflied out of existence. Even as it is, there is some excuse, perhaps, for the cook who unwittingly treats us to the larvæ 'served up hot' in the dining-room.

A collector who has been 'doing' the butterflies for only a very short time has already obtained all the *common* whites he requires, and so neglects these for the more highly coloured species; but a very young beginner will sometimes continue for a whole season to net indiscriminately *all* the butterflies he can catch. It thus often happens that a rarer species, such as a Bath White or a Black-veined, becomes the captive of the novice, when it would be neglected by a

more experienced collector under the supposition that it was only a common kind; for it is impossible to distinguish between some

FIG. 69.—THE SMALL WHITE (MALE).

FIG. 70.—THE SMALL WHITE (FEMALE)

FIG. 71.—THE GREEN-VEINED WHITE. UNDER SIDE.

species while on the wing. Those in search of these rarer whites should be careful to choose the right time of the year, and then net all the doubtful specimens they see.

FIG. 72.—THE BATH WHITE.

The fragile little Wood White, which frequents the open spaces in woods, is not so easily mistaken when flying.

Some butterflies are very capricious in their visits, sometimes

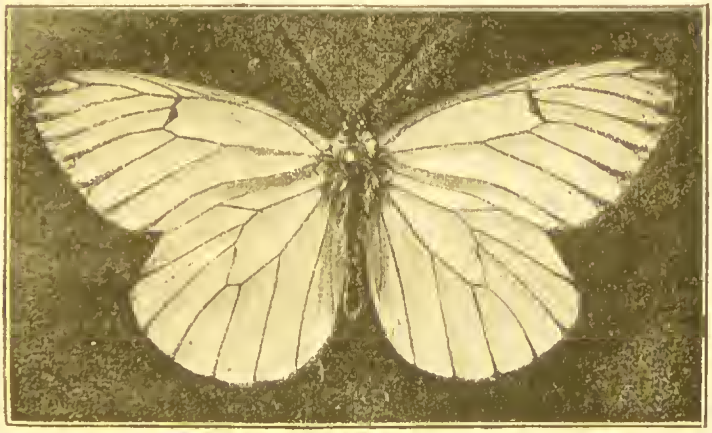

FIG. 73.—THE BLACK-VEINED WHITE.

scarcely showing themselves for several seasons in succession, and then suddenly turning up in such numbers that they may be described as abundant. Of this character is the Clouded Yellow,

which in 1892 visited us in multitudes after about fifteen years of comparative scarcity. The Clouded Sulphur (Plate II) is very similar in its markings to the Clouded Yellow, but the ground colour of the wings is much paler.

Fig. 74.—The Wood White.

The other yellow 'whites' are the Orange Tip (Plate II), the female of which is *not* tipped with orange; and the Brimstone (Plate II). This last-named fly is unique for the particularly graceful outline of the wings, and also for the beautiful silky hair of the thorax, which looks as if it had been carefully brushed upwards

Fig. 75.—The Clouded Yellow. Female and Larva.
(Male shown on Plate II.)

from the sides. The female Brimstone is much paler than the male, and has a decidedly greenish tinge.

The Vanessas

This group includes some very handsome butterflies, of which a few, such as the Peacock (Plate III), the Tortoiseshell (Plate III),

Fig. 76.—The Large Tortoiseshell.

and the Red Admiral (Plate III), are as common as they are beautiful. In all this family the front pair of legs in the perfect

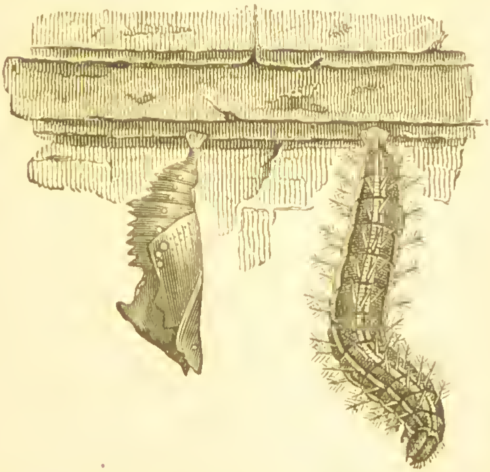

Fig. 77.—Chrysalis of the Large Tortoiseshell; and a Larva suspended just previous to undergoing its change.

insect is not fully developed, and is not used for walking. Many of the larvæ are covered with spines; and some are gregarious, feeding

so close together and in such numbers that the food-plant is almost covered with them.

As a rule, the Vanessas are in their prime during the middle and end of summer; but in some cases we have two distinct broods in a year. Again, we meet with many very early in the season; but these are specimens which have hibernated during the winter in the perfect form, and are too much worn to be of use in the cabinet; but the captive females will often supply you with plenty of eggs from which you can rear the insects to perfection.

Some of the Vanessas are exceedingly bold, and even impudent. They will frequently return immediately after having evaded the first stroke of the net, and then pitch on the ground before you, defiantly raising and depressing their beautiful wings.

Fig. 78. The Comma Butterfly, with Wings Folded. (See also Plate III.)

Fig. 79.—The White Admiral.

The rarest of the family is the Camberwell Beauty (Plate III), so called because a few specimens were taken in Camberwell more than a century since. It has been seen occasionally since, but its appearance and disappearance have been so mysterious, and the favoured localities so numerous and so widely distributed, that it is impossible to say when or where one is likely to meet with it. However, it is a common butterfly on the Continent, and specimens can always be obtained for a few pence. But if the young collector is anxious to become the happy possessor of a really British specimen, let him apply to a dealer, who will supply him with a genuine article, together with written and signed 'data,' for the modest sum of about forty shillings!

The Purple Emperor is well worthy of its title. Its superior

Plate III

size, its majestic and elevated flight, and the grand imperial purple reflected at certain angles from the wings of the male are all unmistakable proofs of its sovereignty. The female is larger than her royal husband, and does not wear the imperial colour which gives the popular name to the species. At one time the capture of a Purple Emperor was reckoned a grand event, and a net mounted on a pole about twenty feet long was considered necessary for his removal from his lofty throne on the oak. But it has since been

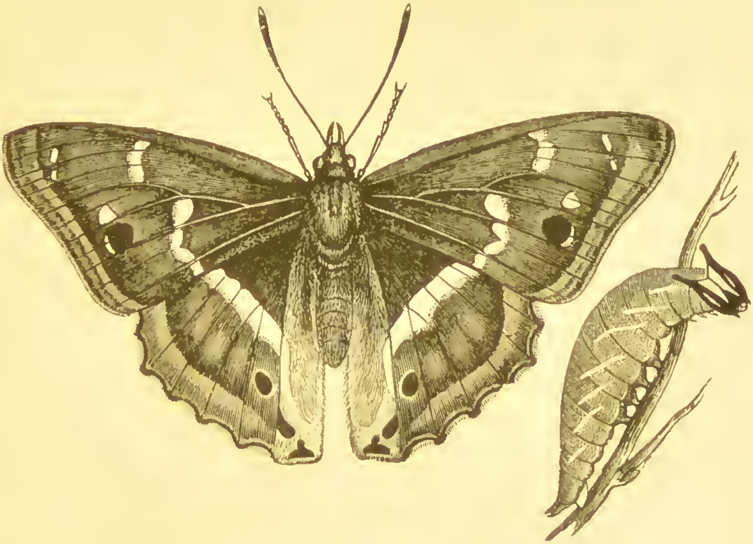

FIG. 80.—THE PURPLE EMPEROR AND LARVA.

discovered that his majesty is particularly partial to high game, and that the odour arising from a decomposing corpse will entice him from his elevated seat. The modern mode of capture is to bait oak woods with dead animals or bullock's liver, and to return in a few days with an *ordinary* net, and capture him while he is absorbed in his luxurious repast. The female Emperor is seldom seen, since she remains at rest on the higher branches, attending to family matters; so that nearly all the Emperors captured are Purple.

The Fritillaries

These pretty butterflies, though numbering nearly a dozen kinds, are remarkably uniform in colour, all being marked with black or deep brown on a ground of light orange brown. Most of them are also characterised by spots or patches of glistening silver on the

under side. They vary considerably in size, the largest—the Silver-washed Fritillary (Plate II)—measuring more than two and a half inches across, while the little Duke of Burgundy is not much more

FIG. 81.—THE DARK GREEN FRITILLARY.

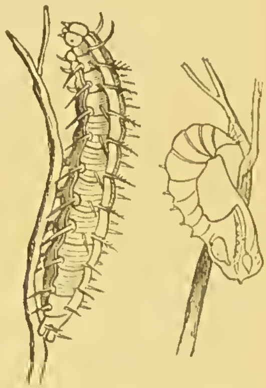

FIG. 82.—LARVA AND PUPA OF THE DARK GREEN FRITILLARY.

than an inch from tip to tip. This latter insect, by the way, although usually grouped with the *Fritillaries*, differs in many important respects from the others. For instance, while the larvæ of all the

FIG. 83.—THE HIGH BROWN FRITILLARY.

FIG. 84.—THE QUEEN OF SPAIN FRITILLARY. UNDER SIDE.

true 'Frits' are long and spiny, that of the Duke is short, thick, and smooth—very much like a woodlouse in form. It is for this reason that we often find the Duke of Burgundy separated from the other butterflies which it so closely resembles, and placed entirely

by itself as the only British member of a family called *Erycinidæ* —a royal personage with no near relatives. In distinguishing between the different species of *Fritillaries* we are guided chiefly by the arrangement of the silver patches and other markings on the

FIG. 85.—THE PEARL-BORDERED FRITILLARY. UPPER AND UNDER SIDES.

under surface. Here we find great variation. Thus, in the largest species just mentioned, the 'silver' looks as if it had been washed over the hind wings. In others we have well-defined spots definitely arranged. But in others—the Glanville, the Pearl-bordered Like-

FIG. 86.—THE SMALL PEARL-BORDERED FRITILLARY.

FIG. 87.—THE GLANVILLE FRITILLARY.

ness, the Greasy (Plate II), and the Duke of Burgundy (Plate II)—the 'silver' is represented by non-metallic white spots. The Greasy Fritillary derives its popular name from the greasy appearance of the under surface of the fore wings.

The 'Browns' and 'Heaths'

We now come to a family in which the prevailing colour is a tawny orange or brown, and of which all the species are characterised

by eye-like spots on the under side. In most cases these 'eyes' are visible, though less distinctly, on the upper surface also.

FIG. 88.—MARBLED WHITE BUTTERFLY.

FIG. 89.—THE SPECKLED WOOD OR WOOD ARGUS.

FIG. 90.—THE WALL BUTTERFLY.

FIG. 91.—THE GRAYLING (FEMALE).

FIG. 92.—THE MEADOW BROWN (MALE).

FIG. 93. THE MEADOW BROWN (FEMALE).

Like the *Vanessas*, all the Browns and Heaths have only four walking legs; but their larvæ, which are all grass-feeders, have no spines; and their pupæ have no angular projections, as is the case with the *Vanessas*.

This group of butterflies includes a few of our commonest and least gaudy species; but a few stand out prominently among them

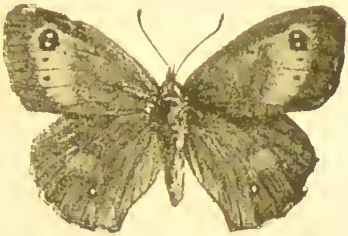

FIG. 94.—THE LARGE HEATH (MALE).

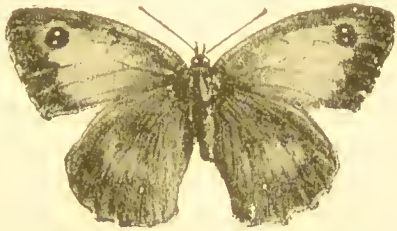

FIG. 95.—THE LARGE HEATH (FEMALE).

FIG. 96.—THE RINGLET. UNDER SIDE.

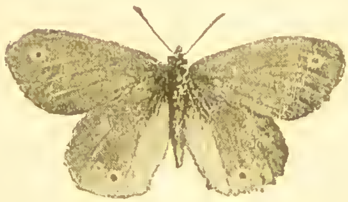

FIG. 97.—THE MARSH RINGLET.

FIG. 98.—THE NORTHERN BROWN OR SCOTCH ARGUS.

FIG. 99.—THE SMALL HEATH.

for boldness of markings; and, though none of them are really rare, yet many are confined to certain very restricted localities.

The Hairstreaks

These butterflies possess very marked characteristics by which they may be readily distinguished from all others. They are not by any means gaily adorned, and their upper surfaces are especially dull and sombre with one exception. They derive their popular

FIG. 100.—THE BROWN HAIRSTREAK. UNDER SURFACE.

FIG. 101.—THE BLACK HAIRSTREAK. UNDER SIDE.

title from the more or less distinct hair-like streaks that cross the wings on the under side. The exception just alluded to is that of the Purple Hairstreak, in which species the beautiful purple reflected at certain angles from the wings of the male reminds one very forcibly of the Purple Emperor.

FIG. 102.—THE WHITE LETTER HAIRSTREAK.

FIG. 103.—THE PURPLE HAIRSTREAK. UNDER SIDE.

FIG. 104.—THE GREEN HAIRSTREAK. UNDER SIDE.

Another distinguishing mark of the Hairstreaks is the tail-like projection on the lower edge of the hind wings; but this is only slightly developed in the case of the Green Hairstreak—the only British butterfly that can boast of a bright green tint.

The 'Coppers' and 'Blues'

At one time we could boast of two Coppers, but it is feared that the finest of these beautiful insects—the Large Copper—has become extinct. It was once very common in the fen districts, and it is

Fig. 105.—The Large Copper Butterfly—Larva, Pupa, and Imago.

still *possible* that it *may* make its appearance again. Let those who have the opportunity search the fens diligently, and *should* any of my readers be so fortunate as to meet with this long-lost

Fig. 106.—The Azure or Holly Blue. Under Side.

Fig. 107.—The Bedford Blue.

gem, our illustration will serve for identification. The Small Copper is common everywhere, and I need hardly mention that it derives its name from the burnished coppery tint of its wings.

As regards the lively Blues, everybody is familiar with their gay tints and frolicsome habits; but the ability to distinguish between

certain similar species is attained only after very careful observation. First we have to notice the different *shades* of blue; then the complicated and variable markings of the under surfaces must be closely

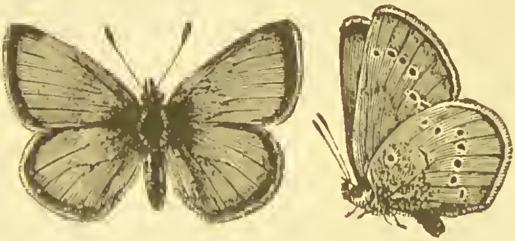

Fig. 108.—The Mazarine Blue. Under Side.

Fig. 109.—The Common Blue (Male).

examined. We have also to remember that *female* Blues are generally *brown*, with perhaps only a sprinkling of the colour that characterises the corresponding males; and, further, that two of the Blues, both the males and females, are not blue at all.

Fig. 110. The Common Blue (Female).

Fig. 111.—The Common Blue. Under Side.

I will just mention a few of the distinguishing marks that are likely to prove most useful:

1. *Azure Blue.*—Bright lilac colour; under side, light silvery blue. Black border narrow in male, broader in female.

Fig. 112.—The Brown Argus.

2. *Bedford Blue.*—The smallest British butterfly. Colour dark brown; male powdered with blue.

3. *Mazarine Blue.*—Deep *purple*-blue, with black border. Female dark brown. Under surface of both sexes drab, with black-centred white spots.

4. *Chalk Hill Blue* (Plate III).—Light silvery greenish-blue. Female brown, and powdered with the colour of the male.

5. *Adonis Blue* (Plate II).—Bright sky-blue. Fringe barred with black. Female dark brown, powdered with blue near the body.

6. *Silver-studded Blue.*—Metallic bluish spots on under surface.

7. *Brown Argus* and *Artaxerxes.* No blue at all.

These are just a few aids to identification; and, with the assistance of our illustrations, will probably prove sufficient. It should also be known that the larvæ of the Blues all resemble the woodlouse in form.

The Skippers

This, our last group of butterflies, receives its name from the peculiar manner in which the insects included flit about. They never keep on the wing for any length of time without resting, but

Fig. 113.—The New Small Skipper.[1]

Fig. 114.—The Dingy Skipper.

seem to *skip* rapidly from flower to flower. In some of their habits they resemble moths rather than butterflies. Thus, their caterpillars protect themselves by rolling up leaves round them; and they also spin silken cocoons when about to change to the chrysalis state. The butterflies are also thick-bodied, like most of the moths; and

Fig. 115.—The Grizzled Skipper.

Fig. 116.—The Chequered Skipper.

their chrysalides resemble those of the nocturnal Lepidoptera. The Skippers are further characterised by the more or less hooked tips of the antennæ.

All the Skippers are small insects; and, although generally very

[1] Discovered in 1888. Distinguished from the Small Skipper (Plate III) by the tips of the antennæ being black beneath.

prettily marked, yet their colours are not at all brilliant, the prevailing tints being various shades of brown.

The space devoted to butterflies has, of necessity, been very limited, and much information of real value to a young collector has, up to the present, been withheld. But this omission is intentional. The reader will probably have noticed that the habitats and seasons of the various butterflies are not given, and that little has been said concerning the food-plants of the caterpillars. Now, it has seemed to me that a twofold advantage would be derived by placing such information as this in the form of a table; for, by so doing, we not only succeed in saving much space, and thus find an opportunity of wedging in a little useful matter which must otherwise have been entirely excluded, but we also present the particulars above mentioned in a form that is likely to be the most convenient for reference.

British Butterflies.

Names	Chief Localities	Seasons	Chief Food-plants
Swallow-tail . . (*Machaon*)	Fens of Cambridgeshire, Norfolk, Huntingdonshire	May *to* August	Wild Carrot, Fennel, Marsh Parsley
Large White . . (*Brassicæ*)	Everywhere	April *to* August	Cabbages and Cresses
Small White . . (*Rapæ*)	Abundant everywhere	"	"
Green-veined White (*Napi*)	"	Throughout the summer. Chiefly May *and* July	"
Bath White . . (*Daplidice*)	South-east. Rare	May *and* August	Wild Mignonette
Brimstone . . . (*Rhamni*)	Southern counties	August *to* October	Buckthorn
Clouded Yellow . (*Edusa*)	South coast	July and August	Clover and Trefoils
Clouded Sulphur (*Hyale*)	South coast	May *and* August	Lucerne
Black-veined White (*Cratægi*)	Very local, chiefly in the South	June and July	Sloe, Hawthorn
Orange Tip. . . (*Cardamines*)	Common in all parts	May and June	Cuckoo-flower
Wood White . . (*Sinapis*)	In various localities throughout England	May *and* August	Trefoils
Painted Lady . . (*Cardui*)	Generally abundant. Uncertain	Spring (H.) [1] August and September	Thistle and Nettle

British Butterflies—*continued.*

Names	Chief Localities	Seasons	Chief Food-plants
Red Admiral . . (*Atalanta*)	Common everywhere	Spring (II.) [1] August and September	Nettle
Peacock . . . . (*Io*)	,,	,,	,,
Camberwell Beauty (*Antiopa*)	Very rare. Uncertain	August and September	Willow
Large Tortoise-shell (*Polychloros*)	Chiefly in South. Uncertain	July and August	Elm
Small Tortoise-shell (*Urticæ*)	Common everywhere	Spring (II.) [1] July and August	Nettle
Comma . . . . (*C. Album*)	Chiefly in Midland and Western counties	,,	Elm, Willow, Sloe, Nettle, &c.
White Admiral . (*Sybilla*)	Oak woods of South	June and July	Honeysuckle
Purple Emperor . (*Iris*)	,,	July	Broad-leaved Sallow
Silver-washed Fritillary (*Paphia*)	Woods of South and Midland counties	July and August	Violet and Nettle
Dark-Green Fritillary (*Aglaia*)	In widely scattered localities throughout England	,,	Dog-violet
High-brown Fritillary (*Adippe*)	Woods of South	July	Violet
Queen of Spain Fritillary (*Lathonia*)	Rare. Chiefly in South	June *and* September	Wild Heartsease
Pearl-bordered Fritillary (*Euphrosyne*)	Woods, throughout England and S. Scotland. Chiefly in the South	May *and* August	Violet
Small Pearl-bordered (*Selene*)	,,	,,	,,
Glanville Fritillary (*Cinxia*)	South and East coasts. Also in S. Scotland	May and June	Narrow-leaved Plantain
Pearl-bordered Likeness (*Athalia*)	In woods. Chiefly in South	,,	Plantains
Greasy Fritillary (*Artemis*)	Chiefly in South. Very local	June	,,

British Butterflies—*continued.*

Names	Chief Localities	Seasons	Chief Food-plants
Duke of Burgundy (*Lucina*)	In woods. Chiefly in South	June *and* August	Primrose
Marbled White . (*Galathea*)	"	July and August	Grasses
Speckled Wood . (*Egeria*)	Common throughout England	April *to* August	"
Wall . . . . . (*Megæra*)	Common everywhere	May *and* August	"
Grayling . . . (*Semele*)	Rocky places. Chiefly in chalk districts. Found in N. England and S. Scotland	July *to* September	"
Meadow Brown . (*Janira*)	Common everywhere	June *to* August	"
Large Heath . . (*Tithonus*)	Common throughout England and S. Scotland	July and August	"
Ringlet . . . . (*Hyperanthus*)	Generally common	June and July	"
Scotch Argus . . (*Blandina*)	N. England and Scotland	August and September	"
Mountain Ringlet (*Cassiope*)	Mountainous districts of N. England and Scotland	June and July	"
Marsh Ringlet . (*Davus*)	Wild moors of N. England and Scotland	"	"
Small Heath . . (*Pamphilus*)	Generally common	June *to* September	"
Brown Hairstreak (*Betulæ*)	Not abundant, but widely distributed. Chiefly in South	August	Birch and Sloe
Black Hairstreak (*Pruni*)	Rare. Chiefly in South	July	Sloe
White Letter Hairstreak (*W. Album*)	Various widely distributed localities	"	Elm
Purple Hairstreak (*Quercus*)	In oak woods throughout England	July and August	Oak
Green Hairstreak (*Rubi*)	Throughout England and S. Scotland	May *and* August	Bramble
Small Copper . . (*Phlæas*)	Common everywhere	April, June, *and* August	Sorrel

BRITISH BUTTERFLIES—*continued.*

Names	Chief Localities	Seasons	Chief Food-plants
Azure Blue . . (*Argiolus*)	In woods throughout England. Chiefly in South	April *and* August	*Flowers* of Holly and Ivy
Bedford Blue . . (*Alsus*)	In limestone districts throughout Great Britain	May and June	*Flowers* of the Kidney Vetch
Mazarine Blue . (*Acis*)	Now very rare	July	*Flowers* of Thrift
Large Blue . . *Arion*)	Rare. Very local. Various limestone and chalk districts of the South	"	Thyme
Chalk Hill Blue . (*Corydon*)	Chalk downs of South	July and August	Clovers and Vetches
Clifden Blue . . (*Adonis*)	"	May *and* August	"
Common Blue . (*Alexis*)	In meadows. Common everywhere	May *to* September	Trefoils
Silver-studded Blue (*Ægon*)	Common in various localities throughout England and S. Scotland	July and August	Broom
Brown Argus . . (*Agestis*)	Chalk downs of South	May and June	Hemlock Stork's-bill
Artaxerxes . .	N. England and Scotland	July and August	Rock Cistus
Lulworth Skipper (*Actæon*)	S. coast of Devon and Dorset	/ "	Grasses
Small Skipper . (*Linea*)	Common in most parts	July	"
New Small Skipper (*Lineola*)	S.E. of England	July and August	"
Large Skipper . (*Sylvanus*)	Common in most parts	May *and* August	"
Silver-spotted Skipper (*Comma*)	Various localities in the South	July and August	Trefoils
Grizzled Skipper (*Alveolus*)	Common in England and S. Scotland	May *and* August	Wild Raspberry
Dingy Skipper . (*Tages*)	"	"	Bird's-foot
Chequered Skipper (*Paniscus*)	Very local. Chiefly in Southern counties	June	Plantain

[1] H. signifies hibernated specimens.

Moth Catching

The collecting of butterflies is the favourite pursuit of the entomologist during the hottest and brightest hours of the summer; but now we have to learn that there is much interesting and profitable work to be done during the dark hours of the summer nights. Moths are, generally speaking, lovers of darkness; but there are a few which are seen at large in broad daylight—some, such as the Foresters, the Clearwings, and the Humming Bird Moth, even delighting in the full blaze of the midday sun. Specimens of these are consequently included occasionally among the 'takings' of a butterfly day; and, in addition to this, a great many moths may be secured during the daytime by searching out their hiding-places, and also by rousing them out of their midday slumbers, thus compelling them to take to the wing at untimely hours. The collecting of both butterflies and moths might well be combined for the same day's outing, giving the sunny hours, up to about four o'clock, almost exclusively to the former, and then, on the way homeward, gently beating the low branches of trees, the underwood, and the low herbage, catching the moths required, by means of the net, as they are driven from their haunts. As a rule, the moths secured in this way are neither the rarest nor the most beautiful; but a great variety of species may be thus obtained, and occasionally a valuable specimen may be included in the catch. The most successful beating may be carried on along the borders of woods, and in hedges surrounding flowery meadows and overgrown waste lands.

Having secured a moth in the net, what is to be done with it? The treatment suggested for butterflies—the pinching of the thorax—might certainly be tried in the case of the *Geometers* and other small-bodied moths; but with the large-bodied species this is not practicable. And some of the latter are so vigorous, and so liable to flutter furiously in the net, damaging their wings almost immediately, that they must be removed with the greatest care and dexterity. Perhaps nothing is so convenient and safe as to pass the open cyanide bottle or laurel box quickly into the net, and coax the captive into it by the assistance of the other hand outside the net. Then, keeping the mouth of the box or bottle covered by the hand for a few seconds, the insect is quieted, and the cork or lid may be replaced. Never allow many moths to accumulate in the killing apparatus; but, after each few captures, pin the specimens in the collecting box.

During any part of the day or evening, when the collector is not directly engaged in his pursuit, he should examine the barks of trees and all wood fences along his path; and he will probably be rewarded with a few uncommon varieties. With regard to the barks of trees, however, he must understand that a very careful examination is sometimes necessary, since a great many moths are coloured with tints very closely resembling those of the particular bark on which they are in tho habit of settling by day; and by this 'protective mimicry' they often elude their enemies. In addition to trees and fences, all isolated posts, and walls, and other surfaces, more or less sheltered, should receive a passing glance. In all cases the north and north-east sides are likely to give the best results, as most moths select these as a protection against the sun.

Taking a moth from a tree, wall, or fence, by day, is generally a very simple matter. The usual method is what is termed 'pill-boxing:'—An open pill box is placed beside the insect with one hand, and the cover made to approach it by the other. Pill boxes with glass *bottoms* are sold for this purpose, and are very convenient since they enable one to see the best opportunity for popping on the cover without injuring the moth. As a rulo the moths are sleepy by day, and take to their new lodgings quietly; but some are very frisky, and flutter about in the box till their wings are almost stripped of scales. For this reason I seldom use pill boxes for moths, except in the case of females from which I am desirous of obtaining eggs for rearing. I have found nothing more convenient and more safe than a wide-mouthed cyanide bottle or a laurel box used in the same way as the pill boxes; or, in the case of the sluggish species, the killing bottle may be held just under the insect, which is then tipped into it with a small piece of twig. On one occasion, while walking through a street in a London suburb, I coveted a pair of Lime Hawks which I had seen on the trunk of a tree, at a height of about twelve feet: but could see no chance of getting them. A few hours later, while at home, I found that I should have to pass through the same road again; so I made a small net, only about four inches in diameter and six inches deep, that could be readily fixed on the top of a three-joint bamboo fishing rod. Armed with net and rod, I secured my two Hawks and a few other moths, and have since made many similar captures with this same apparatus, which, although made hastily on the spur of the moment, I now regard as a useful accessory.

Now for the night work. A great deal of this may be done at

home, especially when there is a garden attached. It is a well-known fact that moths are attracted by lights, and if the collector is not disposed to ramble in search of them, let him sit at home before an open window, with a light to attract the insects, and his net and killing bottle at hand. While writing these lines (July) my gas bracket, with the light shielded by means of wire gauze, is turned close to the open window. One by one the moths approach —some rush with great force against the glass and fall stunned on the window sill; some make straight for the flame, but are saved from an untimely scorching by the gauze, round which they flutter, or on which they settle; others alight quietly on the glass, and there remain stationary, enjoying the light till they are bottled; others, again, make straight for the white ceiling, and there buzz actively round till a fortunate stroke of the net secures them. But a good number of the insects merely *approach* the window, take a brief glance at the light, and then move on about their business. To catch such as these it is necessary to stand at the window with net in hand, ready at any moment to strike. My own experience seems to show that the best specimens are generally to be obtained in this way; the majority of those which allow themselves to be so easily caught being the common species of the *Noctuæ* and the *Geometers*. Occasionally I treat myself to the luxury of a lime light in the window. This enables me to see most distinctly even the smallest of the moths that fly in the garden, and, of course, will also attract numbers to the room.

For out-of-door work a lantern is essential. Almost any kind of lantern will *do*, but preference is to be given to one with a bent glass front, since it throws its light to the sides of, as well as before the operator, and also because no shadows break the field. The lantern should hang round the neck, and be strapped closely to the chest, thus leaving both hands free to manipulate the net and the bottle. A great deal depends on the choice of the night, and also on the time. Windy nights as a rule are bad, especially if the wind blows from the north or the north-east. Moonlight nights also give very unsatisfactory results. The greatest success may generally be expected on a dark and drizzly night, or on a dark night just after rain. The search should commence soon after sunset, and may continue for about an hour, say up to about 9.30. Then for an hour or more the moths are—for some reason or other not properly understood, I believe—rather quiet. But they renew their activity at about an hour before midnight, and continue to appear from that

time up to about 2 A.M., when even the most enthusiastic of entomologists may as well retire to rest. Of course there are early and late species among the moths as well as among the butterflies. Some often appear before the winter snows have all gone; and others linger on till the cold December winds cut short their career. But the lantern season—that is, the period during which *profitable* moth-hunting can be carried on—is comparatively short, extending only from the end of June to the beginning of September.

Moths are very fond of sweets, and abound in places where certain nectar-producing flowers are in bloom. The favourite flowers include the ivy, the sallow, honeysuckle, privet, nettles, the common pink, and verbenas. These and other blooms should be carefully examined with the lantern, bottle in hand. Some of the insects will be found so intensely absorbed in the repast that they may be bottled or pill-boxed with ease; but others are either less gluttonous or far more wary, and require some amount of dexterity on the part of the collector. The ivy and the sallow are particular favourites with the moths, and, while examining these blooms, the entomologist is often sorely tantalised by the sight of 'sour grapes' beyond his reach. Some collectors make use of a lantern and a small net, both mounted on the end of a stick. This is held aloft in the left hand; and the moths are toppled from the blossoms into the net by means of another stick in the right hand.

If the hunting-ground does not abound in such flowers as provide the moths with natural sweets, we can allure them with artificial bait. This plan is commonly known as 'sugaring,' and is conducted as follows: Boiling water is thrown on some very dark and strongly smelling sugar, and the mixture is well stirred. In this way a very strong syrup is made, and this is kept as 'stock.' When the sugaring is to be tried, take as much of this syrup as may be required, mix it with some rum, and apply the mixture with a paint brush to the barks of trees or to palings. This should be done just at the time when moths are likely to appear. Attracted by the odour, they will settle, one by one, beside the luscious spread, some taking only a hasty sip and then moving on, and others gorging themselves till they drop intoxicated on the ground beneath. At intervals a very cautious approach should be made towards tho painted surfaces with a lantern, securing first those insects which exhibit a restless disposition by the vibration of their wings, and then leisurely bottling the lazy and the gluttonous. It must not bo supposed, however, that *every* night at sugaring will prove equally

successful. Sometimes hardly a moth will come to the feast, but at other times numbers are attracted. As a rule the majority are among the common species—chiefly *Noctuæ*—but fine specimens of rarer moths are frequently captured by this method. The above mixture is one commonly used; but some entomologists mix their sugar with beer instead of water, and others use molasses instead of sugar. Whatever be the mixture, it must be remembered that it is the *odour* that attracts the moths, and not the *quality* of the viands; so that the nose is to be the sole judge in the selection of the sugar or the molasses to be employed. Again, some collectors, instead of using the sugar as paint, applying it with a brush, take out with them some pieces of rag which have been steeped in the mixture, and simply pin these to the barks of trees.

Setting and Preserving Moths

Moths are to be set in exactly the same manner as butterflies; but there are a few little matters of detail to which we must attend if we aim at perfect appearance and good preservation. In the first place, many of the moths are so very small and fragile that the thinnest pins must be used; otherwise the specimens will not only look very clumsy, but the limbs will be disarranged or broken as we pierce them. Again, a large number of the moths have very long and slender antennæ, which have a tendency to curl very irregularly as they dry; and it will be necessary to look at these occasionally while on the setting board, and adjust the antennæ when required.

But the greatest troubles will occur in our dealings with the larger and thick-bodied species. The large bodies of the Hawk moths, for example, will shrivel up in drying till they have entirely lost their graceful outline and plump figure. To prevent this, these moths must be stuffed. This may be done by slitting open the abdomen beneath with a sharp knife, removing *all* its contents, and then packing it rather tightly with cotton wool. A better plan is to cut the abdomen completely off at the waist, remove its contents carefully with a little hooked wire, and stuff it at the cut end. Then, when both parts of the insect are perfectly dry, the abdomen may be again attached with a little coaguline. If this last operation be performed skilfully, the junction will not be seen, and the insect is apparently so perfect that it may be pinned to exhibit either the upper or lower surface. As a further precaution some entomologists introduce into the stuffed abdomen a small quantity


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of some poisonous substance to prevent the intrusion of mites. I have seen benzole recommended for this purpose; but this, being a very volatile liquid, soon evaporates, leaving the body of the insect just as harmless to the mites as it was previously. Nothing, perhaps, is so effectual as a little powdered corrosive sublimate; but as this is a powerful poison, it should always be handled with caution.

We have now to tackle the *greatest* enemy of the moth collector —'grease.' Let the reader set a moth—a 'Ghost,' for example—put it away in the store box, and examine it closely at intervals. After a few weeks, or perhaps months, he will notice that a fatty substance has oozed out of the abdomen. This gradually creeps over the surface of the body, and at last spreads all over the wings, making the insect look as if it had been plunged bodily into oil. But *nil desperandum*; our specimen is not spoilt beyond recovery. Plunge it into a vessel of benzoline, benzole, or ether, and let it remain there for a day or two. When you take it out again it looks worse than before. But now pin it under a window that is slightly open, or in some other spot where it may dry in a current of air. The volatile liquid will soon evaporate, leaving the insect in all its original beauty. The above is the *cure* for 'grease;' but the old maxim says 'prevention is better than cure,' and the proverb certainly applies in this case. Therefore, if you have a moth that you know is of a greasy disposition, cut off its abdomen before you put it in the store box, and treat the troublesome portion only in the manner described above, without waiting till the fatty substance shows itself on the surface. Also, when you are about to stuff a large specimen, soak the abdomen in one of the liquids named, immediately after the contents have been removed, and you will then have no further trouble and disappointment. Finally, there is yet another method of disposing of the superfluous fat—a method especially suitable to the smaller moths that require no stuffing. It is this: Remove the abdomen, and put it in a bottle of magnesia or other absorbent powder; and, after the grease has all been absorbed, brush it lightly and fix it on again as before described.

The Hawk Moths

About two thousand species of moths are known in the British Isles, and it is probable that there are still many to be discovered. Our limited space will not allow us to examine more than a few of

the commoner and more conspicuous species. And the descriptions of the samples selected must necessarily be short; in fact, in some cases little more than the figure will be given.

We will first take the *Sphingidæ*, or *Sphinx Moths* or *Hawk Moths*. The term *Sphinx* is applied to the members of this family on account of the fancied resemblance of the caterpillars (or, as

Fig. 117.—The Death's-head Hawk Moth (*Atropos*).

some say, the chrysalis) to the Egyptian Sphinx; and they are called Hawk Moths from the peculiarity of their flight. All these moths are heavily built; their bodies are thick, and their wings strong and powerful. Their mode of feeding is peculiar. They remain poised in the air by means of a very rapid motion of the wings—so rapid, indeed, that nothing is seen except the motionless body surrounded by a mist. While thus balanced,

their very long sucking tubes are thrust into the nectar-bearing flowers; and, the feast being over, they dart away with amazing rapidity. Most of the 'Hawks' fly only at night, and consequently are seldom seen; but if one will remain perfectly still near a bed of petunias or verbenas, on which fall the rays of a lantern, he will almost certainly have the pleasure of witnessing the

FIG. 118.—THE LARVA OF THE DEATH'S-HEAD HAWK.

wonderful movements, and of hearing the hum of some of these beautiful insects.

The Death's-head Hawk Moth (*Acherontia atropos*) is a very powerful insect, measuring about five inches from tip to tip. Its fore wings are beautifully mottled with different shades of brown, and the hind wings are yellow with black bands. The body also is banded with yellow and black, and the thorax has a very conspicuous mark which reminds us at once of the human skull. The

caterpillars, like those of all the *Sphingidæ*, are smooth and without hairs; and, like most of these larvæ, have a horn above the tail. They feed at night, during July and August, on the potato and the deadly nightshade; and are known to potato growers as the 'locust.' The chrysalis is often dug up by the labourers in potato fields in September, and commonly goes by the name of 'ground grub.'

The best way to secure perfect specimens of the Death's-head Moth is to obtain the assistance of a potato-grower in collecting either the fully grown caterpillars in August, or the pupæ in Sep-

FIG. 119.—THE EYED HAWK (*Ocellatus*).

tember. If the former, they must be supplied daily with fresh potato leaves till about to change; and the pupæ should be kept in *moist* earth till the perfect insects emerge. This insect is unique on account of its remarkable power of producing a sharp sound when irritated; and this strange propensity is common, more or less, to all three stages.

The caterpillars of most of the Hawk Moths are easily bred in confinement, and this is most certainly the best method of obtaining the perfect insects, not only because we thus secure the most perfect specimens, but also because it affords an opportunity of becoming acquainted with the insects in all their stages. As a

rule the larvæ are easily obtained by beating the branches of the food plants.

The Humming-bird Hawk, though not by any means a brilliant insect, is very interesting on account of its peculiar habits. Unlike most moths, it delights in the hottest sunshine, and may often be

Fig. 120.—Larva of the Spurge Hawk. (Perfect Insect shown on Plate V.)

Fig. 121.—The Humming-bird Hawk (*Stellatarum*).

observed on bright days hovering over flowers, its wings being almost invisible on account of their rapid motion. The slightest movement on the part of the spectator will cause the insect to dart off with lightning-like velocity, but it will often return again to the very same flower if the intruder does not approach too near,

The Wood-borers

The members of this group vary so much in size and appearance that those who are unacquainted with their histories will naturally be surprised on finding them placed together. It is in the larval state, however, that they show their relationship; for all their caterpillars live inside the stems or trunks of plants and trees, and feed entirely on the solid wood or the pith. Some of their larvæ look much like large white maggots; but others are fine, large, and well-formed caterpillars, which live four years or more in the solid wood of large

trees. Nearly every old willow tree is riddled completely through and through with the borings of these voracious wood-eaters; and elms, poplars, and other trees are often similarly attacked. These destructive caterpillars always avoid the light, and so it generally happens that the infested tree shows no outward signs of its actual condition; but when a portion of the bark has been removed, the perforations in the wood are exposed, and a small heap of the chipped wood, resembling sawdust, may often be found at the base of the trunk.

They change to the chrysalis inside their borings, some of them previously constructing a tough cocoon composed of the gnawed wood spun together with silk, but others remaining quite uncovered save by the substance of the stem itself. Some of these latter chrysalides are provided with little hooks at each segment, and by means of these they can work themselves along their galleries almost as rapidly as they could walk when in the larval state.


FIG. 122. THE HORNET CLEARWING (*S. Apiformis*).

The *Sesidæ* or Clearwings form an interesting division of this group. At first sight it would appear that the term 'scaly-winged' does not apply to them, for their wings are almost entirely scaleless. In fact, so beautifully transparent are they, that the Clearwings may easily be mistaken for gnats, bees, or wasps.

The fore wings of these beautiful insects are banded with either white, yellow, orange, or red; but the hind pair are free from such markings. Most of them, too, have tufts of hair at the tip of the abdomen.

Those in search of Clearwings should examine the stems and twigs of their food plants, the chief of which are the pear, apple, birch, osier, elm, currant, alder, ash, and poplar.

The next family of Wood-borers (*Zeuzeridæ*) includes the Reed Moth, the Wood Leopard, and the Goat Moth. The larva of the first of these feeds on the interior of reed stems, and that of the second on the wood of elm and fruit trees. The Goat Moth is one of our largest British insects, and is so called from the disagreeable odour emitted by the larva—an odour which is said to resemble that of the he-goat. This fine caterpillar spends four years in the

wood of the willow or elm. For some time I was under the impression that this larva could thrive only on the wood of living

FIG. 123.—THE LEOPARD MOTH (*Æsculi*) AND LARVA.

FIG. 124.—THE GOAT MOTH (*Ligniperda*) AND LARVA (THE LATTER ABOUT ONE-THIRD GROWN).

trees, but I have recently obtained some fine specimens from rotting wood that had been lying on the ground for years; and these are still feeding in confinement on the same material.

FIG. 125.—THE COMMON SWIFT (*Lupulinus*).

FIG. 126.—THE GHOST SWIFT (*Humuli*).

Our last examples of the wood-eaters are the Swifts (*Hepialidæ*), the larvæ of which feed on the roots of various plants.

The Burnets

These are beautiful little moths, fond of flying about in bright sunshine. When on the wing they make rapid progress, and may then be mistaken for bright-coloured bees. Towards evening, and during the day in dull weather, they rest on the stems of plants, and are then easily taken with a box. The fore wings, except in the case of the Transparent Burnet, are of a beautiful metallic blackish green, boldly marked with bright red spots; and the hind wings are bright crimson, bordered with black. Their caterpillars feed on trefoils and vetches, and spin silky cocoons on the upper parts of tall stems.

FIG. 127.—LARVA AND COCOON OF THE SIX-SPOT BURNET.

The commonest of our Burnets — the Six-spot — is shown on Plate IV.

The Eucheliidæ

This small family includes the Cinnabar Moth (Plate IV) and the Scarlet Tiger. The former is so called from the cinnabar crimson of the hind wings. This insect sometimes appears in multitudes in spots where its food plant (the ragwort) flourishes; but in some localities it is very scarce, even though the ragwort grows in profusion. Its yellow and black banded larva is generally well known. The Scarlet Tiger (Plate V) is also plentiful locally, and is most certainly one of the loveliest of British insects.

FIG. 128.—LARVA OF THE CINNABAR MOTH (*Jacobææ*).

The Tiger Moths

The Tiger Moths (*Cheloniidæ*) are very well known, and are ever popular on account of their gay appearance. All the males of

FIG. 129.—THE CREAM-SPOT TIGER (*Villica*).

FIG. 130.—THE BUFF ERMINE (*Lubricipeda*).

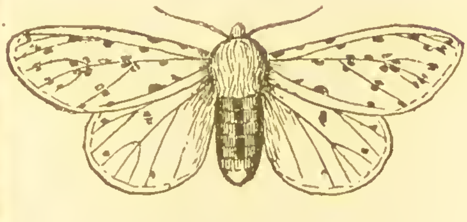

FIG. 131.—THE WHITE ERMINE (*Menthastri*).

this family may be distinguished from their mates by the fringed

or feathered antennæ. Their caterpillars are all very hairy, and roll themselves up in a ring when disturbed. Of these the 'Woolly Bear'—the larva of the Common Tiger (Plate IV)—is one of the commonest objects of the country. When the caterpillars of the Tigers are full fed they all spin loose silken cocoons in which their hairs are intermingled with the silk fibres. We cannot find space to describe these insects individually, but the illustrations of some of the commoner species on Plates IV and V will serve for identification. The less gaudy Ermines—Buff and White—are included in this family.

The Liparidæ

The chief characteristics of this family are the peculiar brush-like tufts of stiff hair which ornament the caterpillars, and, what is

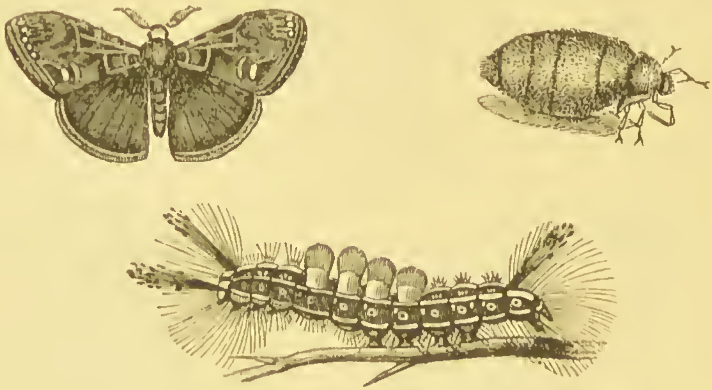

Fig. 132.—The Vapourer Moth (*Antiqua*) Male, Female, and Larva.

still more remarkable, the chrysalides are also hairy. A glance at our illustration of the larva of the Vapourer Moth will probably remind the reader of an object he has seen scores of times. Even in the streets of densely populated towns we invariably come across this caterpillar; and during the autumn the chestnut-brown moth may be seen gaily flitting about in the smoky thoroughfares of our cities. The Vapourer has yet another peculiarity, for the female is quite wingless. She never leaves the silken web which she constructed while a caterpillar. On this web she deposits her eggs; and, having performed this, her only duty, on this same

Fig. 133.—The Brown Tail (*Chrysorrhœa*).

web she ends her existence. Among the other members of this family we introduce figures of the Brown Tail and the Black Arches.

Fig. 134.—The Black Arches (*Monacha*).

Fig. 135.—The Black Arches. (Dark variety.)

The last-named moth is noticeable for the very variable proportion of black and white in the markings of its wings.

The Bombycidæ

This is a family of full-bodied moths, in which the prevailing colours are brown and grey. Most of their caterpillars are very hairy, but all the chrysalides are smooth. Perhaps the best known among these is the Oak Eggar (Plate IV), so called on account of the egg-like shape of the tough cocoon spun by the caterpillar. This caterpillar is a most beautiful creature. Its body is a rich velvet-black colour, but it is so thickly covered with brown hair that the ground colour is entirely hidden when the body is straight. But when the insect curves its body in walking, or

Fig. 136. The Small Eggar (*Lanestris*).

when it curls its body into a ring as is its habit on being alarmed, the rich black colour is exposed in the form of bands between the

Fig. 137.—The Lackey (*Neustria*).

Fig. 138.—The Lappet Moth (*Quercifolia*) and Larva. (See also Plate V.)

segments. The male of the perfect insect is much smaller than the female, and darker in colour, but otherwise similar. I have

seen large numbers of Eggars flying about in bright sunshine along the rugged cliffs of Cornwall. These were all males, and not one of them was seen to settle. However, I succeeded in netting a few by standing ready, with uplifted net, intercepting them as they passed, for chase was quite hopeless.

The *Bômbycidæ* include also the Small Eggar, Pale Eggar, the Lackey, the Drinker, the Lappet, and the Emperor (Plate IV).

With regard to the Drinker, it is but fair to the perfect insect that I should mention the fact that it is the larva only which indulges in the habit which has given rise to the popular name.

In the case of the Lappet we have another good example of 'protective imitation.' The creature closes its wings in such a manner that it looks much like a decayed leaf; and with this deceptive resemblance it is secure from its enemies while at rest on the trees during the daytime

The Geometers

We now come to a very extensive group of moths known as the *Geometers* or *Loopers*. Both these terms, however, really apply to the caterpillars, and not to the perfect insects. Let us see how. If you examine one of these creatures you will observe that its body is long, slender, and cylindrical; its surface is also smooth and

FIG. 139.—THE SWALLOW-TAIL MOTH (*Sambucata*).

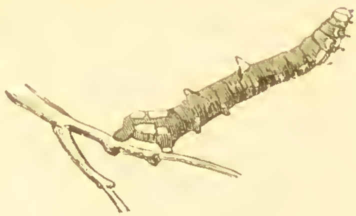

FIG. 140.—LARVA OF THE BRIMSTONE MOTH. (PERFECT INSECT ON PLATE IV.)

quite free from hairs. At its hinder extremity will be seen only *two* pairs of claspers, thus leaving a very large proportion of its length without limbs. Now put it down, and watch its peculiar mode of progression. First it bends its long body into a loop, bringing its claspers close up to the legs in front; and then, keeping its claspers still fixed, it throws its head forward till the body is

again perfectly straight. Thus, by a series of long strides, it moves itself along, *measuring* the ground over which it travels, and con-

FIG. 141.—THE BRINDLED BEAUTY (*Hirtaria*) AND LARVA.

FIG. 142.—THE PEPPERED MOTH (*Betularia*)—MALE.

FIG. 143.—THE GREY SCALLOPED BAR (*Belgiaria*).

FIG. 144.—THE MAGPIE (*Grossulariata*).

verting its body into a kind of land-surveyor's chain. You will now see that the word *Geometer*, which signifies '*earth-measurer*,' is very appropriate.

In these interesting caterpillars we meet with many remarkable instances of protective resemblance. When at rest they remain quite motionless on the food-plant, commonly selecting a stem or twig as the place of repose. Some of them lie close against the stem, but many hold on firmly with their claspers, stretching their

Fig. 145.—The Mottled Umber (*Defolaria*)—Male, Wingless Female, and Larva.

bodies rigidly out at an angle. In this latter position they so closely resemble the stems to which they attach themselves, that even the most practised eye may be deceived; and the imitation is rendered still more complete by the colouring and other characteristics of the caterpillars. The green species rest on green stems, and others

Fig. 146.—The Winter Moth (*Brumata*).

Fig. 147.—The Beautiful Carpet (*Albicillata*).

of dull brownish tints on twigs covered with bark of similar colour. We even find bumps and markings on their bodies almost exactly corresponding with the projections and variations on the twigs of their respective food-plants.

The British moths included in the *Geometræ* number nearly three hundred species.

We have seen that it is a very easy matter to distinguish a Looper caterpillar from that of any other family; but it is impossible to give any such reliable marks by which we may *always* recognise

FIG. 148.—THE ARGENT AND SABLE (*Hastata*).

FIG. 149.—THE SILVER-GROUND CARPET (*Montana*).

a Geometer Moth. It may, however, generally be known by its slender body and comparatively large wings. And yet another feature is worthy of notice. In a large number of the Geometers

FIG. 150.—THE MARSH CARPET (*Sagittata*).

FIG. 151.—THE COMMON CARPET (*Subtristata*).

FIG. 152.—THE CHIMNEY SWEEP (*Chærophyllata*).

we find the hind pair of wings marked much after the same pattern as the fore pair; but in the other moths we usually find the hind wings very unlike the others.

The Cuspidates

The caterpillars of this division are generally very curious objects. The bodies of many of them taper to a point behind, and some of

FIG. 153.—THE SALLOW KITTEN (*Furcula*).

them terminate in one or two slender 'tails.' In many cases, too, their backs have one or more humps, and these add to their strange

Plate V

appearance. These caterpillars never roll themselves into a ring when alarmed, nor do they allow themselves to fall from their food-

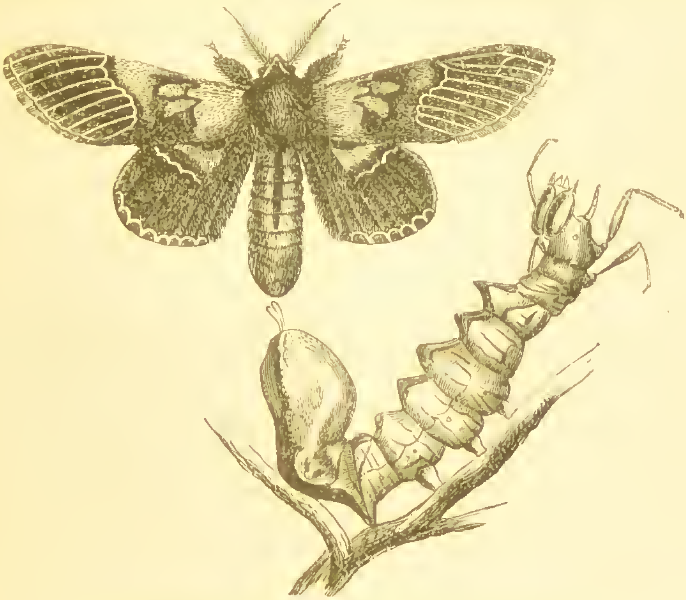

Fig. 154.—The Lobster Moth (*Fagi*) and Larva.

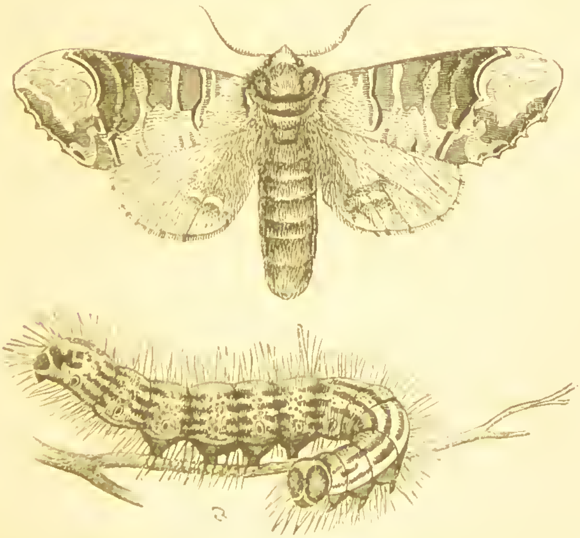

Fig. 155.—The Buff Tip Moth (*Bucephala*) and Larva. (See also Plate V.)

plants when disturbed—their only protection from their enemies seems to lie in their colouring, the prevailing tint being a beautiful leafy green.

Some of them—the Puss and the Kittens, for example—adopt a novel method of protecting themselves when about to change to the

FIG. 156.—PUSS MOTH (*Vinula*) AND LARVA.

pupal state. They descend to the trunk of the tree on which they have fed, and there construct a very hard cocoon of fragments of bark glued together by a sticky substance from their own bodies; and this is so cleverly made that it is almost impossible to detect it. Others spin for themselves a light silken cocoon between the leaves; but, as winter approaches, the leaves fall to the ground, and there

the insects remain till the time comes for their final change. Others, again, construct no kind of habitation, but change to the chrysalis on the surface of the ground or in a burrow which they make in the soil.

The Noctuas

The three hundred British moths belonging to this division are, generally speaking, remarkably uniform in size and colour. In nearly all cases the colouring consists of shades of brown and grey, and the general appearance may be described as dingy rather than

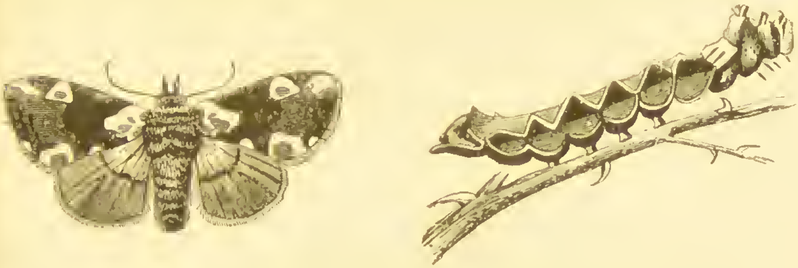

Fig. 157.—The Peach-blossom Moth (*Batis*) and Larva. (See also Plate IV.)

pretty or brilliant. Still there are some grand exceptions to this rule. Take, for instance, the pretty Peach-blossom Moth, with its rich olive brown spotted with pink, reminding us at once of the petals of the flower from which it derives its name; also the beauti-

Fig. 158.—The Grey Dagger (*Psi*).

ful 'Underwings,' rendered conspicuous by the bright yellows, reds, and crimson of the hind pair of wings, and also, in some cases, by their superior size. But, omitting these and the few other *Noctuæ* which stand out boldly among their allies either for brilliancy of colouring or for superiority of size, the monotony is so remarkablo

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that much difficulty will be experienced when the young collector attempts to classify and name his specimens.

Fig. 159. The Cabbage Moth (*Brassicæ*).

Fig. 160.—The Turnip Moth (*Segetum*).

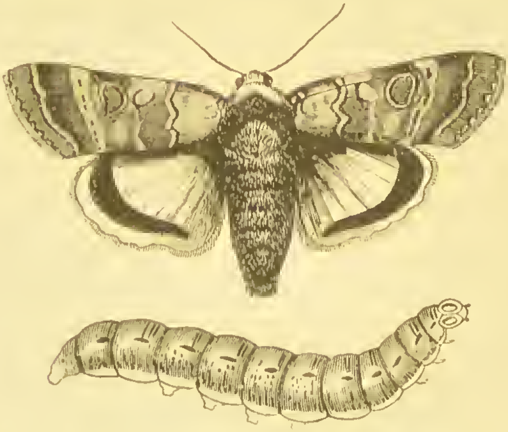

Fig. 161. The Large Yellow Underwing (*Pronuba*) and Larva. (See also Plate V.)

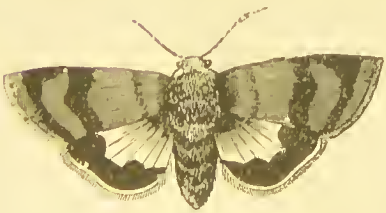

Fig. 162.—The Lesser Broad Border (*Ianthina*).

Fig. 163.—The Dot (*Persicariæ*).

The *Noctuas*, as their name implies, are all night fliers. They are also termed *Owl Moths*, and are sometimes spoken of as the Full-bodied Moths, on account of their comparatively thick bodies.

Their antennæ are long and very slender; and, when at rest, these are snugly tucked in beneath the thorax. At the same time the wings are closed in such a manner that the body is completely hidden from view; and the hind wings, which are generally of a pale dingy colour and quite plain, are covered by the front pair.

FIG. 164.—THE ANGLE SHADES (*Meticulosa*) AND LARVA. (SEE ALSO PLATE V.)

FIG. 165.—THE SILVER Y (*Gamma*).

FIG. 166.—THE BURNISHED BRASS (*Chrysitis*)

All the different modes of capture mentioned in the hints on 'Moth Collecting' may be successfully practised when searching for *Noctuæ*; but, above all things, you *must* remember the greedy appetite of these insects for all kinds of sweets. Throw the light of your lantern on the nectariferous blooms of the sallow, honeysuckle, or ivy, on a calm and damp night, and you are sure to see scores of pairs of

FIG. 167.—THE HERALD MOTH (*Libatrix*) AND LARVA.

Fig. 168.—Mother Shipton (*Mi*).

Fig. 169.—The Red Underwing (*Nupta*).
(See also *Sponsa* on Plate IV.)

Fig. 170.—The Clifden Nonpareil (*Fraxini*).

eyes, glistening like balls of fire. Equally attractive is the naturalist's 'sugar;' and a well-chosen night at 'sugaring' will fill your boxes as rapidly as you could wish.

The caterpillars of the *Noctuas*, unlike the moths, exhibit a great variety of form and colour. Some are smooth and feed by day; others hide all day between leaves spun together, or in some other retreat, and feed only by night. Many are covered with long hair; and a few species crawl with arched backs somewhat after the manner of the Loopers.

The pupæ of the *Noctuæ* are smooth and shining, and generally of a reddish-brown or blackish colour. They are dug up in large numbers in all cultivated soils during the winter, and many are to be found during this season among the roots of trees or among the decayed leaves under the plants on which the caterpillars had been previously feeding.

Deltoides and Pyralides

The *Deltoides* are a group of small moths that have received the above name from the fact that their folded wings take the form

FIG. 171.—THE SNOUT (*Rostralis*).

FIG. 172. THE MEAL MOTH (*Farinalis*).

of the Greek letter Delta (Δ). The group contains many kinds, but we can find room for one only—the Snout.

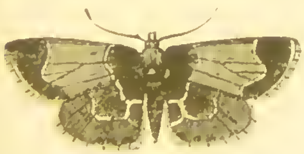

FIG. 173. THE TABBY (*Pinguinalis*).

FIG. 174.—THE MOTHER OF PEARL (*Urticalis*).

Another group of small moths—the *Pyralides*—includes the Meal Moth, the larva of which feeds on various kinds of meal and flour; the Tabby, which, in the larval state, devours greasy cloths

and rugs; the Pearl Moths, the Rust Veneer, and the Beautiful China Mark. The last-named moth is common in the neighbourhood of ponds, and its caterpillar is remarkable for the fact that it lives under water, feeding on the under side of the floating

FIG. 175.—THE RUST VENEER (*Hybridalis*).

FIG. 176.—THE BEAUTIFUL CHINA MARK (*Stagnalis*).

duckweed. Instead of breathing by tracheæ after the manner of other caterpillars, it is supplied with hair-like filaments which serve to extract oxygen from the water. It conceals itself in a case constructed of the epidermis of the weeds.

The Crambites and Tortrices

The first of these groups includes several small moths known popularly as the Veneers, and also the Honeycomb Moth so

FIG. 177.—THE PEARL-STREAK VENEER (*Hamellus*).

FIG. 178. THE HONEYCOMB MOTH (*Cerella*).

destructive to the hives of bees. The larvæ of the latter are annoying pests to bee-keepers, for they eat away the comb and its contents, sometimes almost filling the hive with their silken cocoons. The

FIG. 179.—THE STRAW OBLIQUE BAR (*Costana*).

FIG. 180.—THE HAZEL TORTRIX (*T. Sorbiana*).

first four segments of the larva are so hard and horny that the bee's sting cannot penetrate it, and the softer hinder part of the body is always protected by a tough silken case.

The *Tortrices* or *Twisters* (figs. 179 and 180) are chiefly small moths, the caterpillars of which generally roll up the leaves of the food-plant to form themselves a home. Many of them spend their larval state in the interior of apples and other fruits, often doing great damage to our crops. The perfect insects may be known from other moths by the bell-like form of the wings when folded.

The Tineæ and Plume Moths

The term *Tineæ* is derived from a Latin word which means 'Clothes Moths;' and the group so named contains, among many

Fig. 181.—Leaves, Rolled and Mined.

others, those few species whose larvæ are so destructive to our furs and other clothing. These moths are so very numerous that the study of them is quite a formidable task. Some are so small that it is impossible to set them even with the finest pins procurable, and a magnifying glass is absolutely necessary to make out the markings of their wings. The best, and, in fact, the only satisfactory, way of setting these is to lay out the legs and wings with a fine needle on a card lightly covered with very thin gum.

Fig. 182.—The Woollen Moth.

The common Woollen and Hair Moths lay their eggs in our clothing and furniture, and the larvæ construct for themselves cylindrical cases in which they reside, never exposing more than

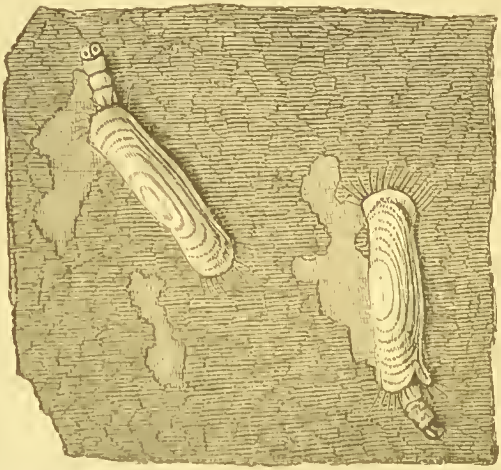

FIG. 183. LARVA OF THE WOOLLEN MOTH.

the first few segments of their bodies. As they move about in search of food they drag their cases behind them just like the larvæ of caddis flies.

The *Tineæ* also include the 'Leaf-miners,' the larvæ of which burrow through the soft cellular structure of leaves. These insects are easily reared. It is simply necessary to cut off a twig on which are burrowed leaves, and, after satisfying yourself that the caterpillars are at home by holding the leaves up to the light and looking

FIG. 184.—THE HAIR MOTH.

FIG. 185. THE PLUME MOTH (*Pentadactylus*).

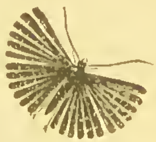

FIG. 186.—PLUME MOTH (*Hexadactyla*).

through them, put the stem in a bottle of water. In a few days the larvæ are full fed, and require no further attention save watching now and again till the perfect insects emerge.

The beautiful little Plume Moths (*Pterophori*) or 'feather-bearers' may be known at a glance by their satin plumes, which display such splendour when expanded in the sunlight. They are rather sluggish insects, and are generally easily captured with a pill box.

Collecting Ova and Larvæ

A large number of the butterflies and moths caught by means of the net or otherwise will be found to be more or less damaged and worn; and only those which have recently emerged exhibit the full beauty of their plumage. Then, again, there are many varieties which are seldom seen on the wing, but of which the larva, or perhaps even the eggs, may be obtained by searching the food-plants. It often happens, too, that we capture the female of a certain species we covet, but in such a worn condition as to be useless for the cabinet. In such a case we may often procure a hundred or more fertile eggs. These are arguments sufficient to prove the advantage to the collector of rearing his own insects; but far and away ahead of all these reasons stands the fact that the true entomologist is desirous of becoming acquainted with insect life in *all* its phases, and this can be done effectually only by breeding various species at home. Another great advantage of rearing from the ova is the perfect freedom from the havoc of the ichneumon flies—a scourge that cuts off a very large proportion of the caterpillars that feed in the open.

Eggs are generally best obtained from females caught at large, or from insects previously bred. *Searching* for eggs is, as a rule, not a very lucrative employment; but occasionally a number of valuable ova may be found by examining the leaves or flowers of the proper food-plants. With low-growing plants the searching is rather tedious, for, the eggs being generally on the under surfaces of leaves, each leaf must be turned over and examined separately. The best results are obtained by searching shrubs and the saplings of large trees, especially those which are on the *borders* of woods, or quite isolated on open ground. You should get under the branches and look upward on the lower surfaces of the leaves. A few of the Lepidoptera lay their eggs on the *upper* surfaces, and among these may be mentioned the Puss Moth, and the Poplar and Sallow Kittens.

Searching for larvæ is a far more productive and interesting occupation. Every plant harbours one or more species. Even the

most poisonous herbs, and the toughest and most prickly of leaves, provide them with sustenance. The under surfaces are generally chosen as a place of repose, and some species remain thus permanently under cover, biting holes as they feed; but the majority feed at the edges of the leaves, changing their position when about to rest. Some lie motionless along the midrib of the leaf. Many of the Loopers fix themselves by their claspers on a stem or twig of the same colour as their own body, and stand off at an angle so as to exactly resemble the stalks which support them. Some caterpillars feed only by night, and many of these descend to the soil, where they hide throughout the day. When searching for tree-feeding larvæ it will be better, as in the case of ova, to examine saplings rather than the branches of large trees, and to select those which are isolated or else on the borders of woods. Partially eaten leaves should always be examined, and branches completely stripped of their leaves will often lead to the discovery of a whole colony of gregarious larvæ. Sometimes it happens that the presence of caterpillars on a tree is far more easily discovered by examining the ground than by looking up at the tree itself, for beneath we may often see the pellets of their excrement thickly strewn about.

Never rely entirely on *searching* for larvæ, for this alone will fill the boxes very slowly. Where they are suspected to be feeding spread a white cloth of some kind on the ground, and tap the branches above it very smartly with a stick, and generally a variety of species—to say nothing of sticks, petals, leaves, earwigs, beetles, spiders, &c.—will at once make their appearance. Instead of the cloth an inverted umbrella with a white lining may be used as recommended for beetle collecting. After *beating* allow the fallen larvæ to get a foothold on your cloth or umbrella, and then hold it up to let all the miscellaneous material drop off. A selection can now be made at your leisure.

Sweeping is another method of collecting larvæ as well as other forms of life. For this purpose a very strong but light net—or rather bag—is made of holland or book muslin; and this is vigorously swept through low-growing herbage by means of a short and strong stick.

Great care must be taken in handling the smaller larvæ, and the various captures should be brought home in boxes with perforated covers, each containing a little moss to give them a foothold. They should not be overcrowded; and, although pill boxes and chip boxes may do for most species, a few tin or zinc larvæ boxes should be

taken for the wood-eating caterpillars, and others which possess powerful biting apparatus.

Larvæ Rearing

Having collected either the ova or the larvæ of any desired species, the next thing to be considered is how to rear them till the perfect form is attained. Eggs may be placed in a wide-mouthed bottle, covered with a piece of muslin or leno, which may be secured by an elastic band round the neck. Here they should be watched daily till the young larvæ are hatched. They must now be supplied with fresh leaves from the proper food-plant about twice a day, each time removing them from the stale leaves with a soft camel-hair brush. Very small species may be kept in such bottles till they change, in which case a little sifted mould or a layer of cocoanut fibre should be put in the bottom for them to spin in. It is also advisable in most cases to place the stem of the food-plant in a very small bottle of water, by which means it may be kept fresh for a much longer time, thus rendering it unnecessary to disturb the young caterpillars so frequently; but in this case the neck of the small bottle must be packed with cotton-wool to prevent them from getting into the water, and a piece of rag or other substance should be so placed that those which fall from the food-plant may crawl up again. These and the following remarks of course apply also to the larvæ which have been collected.

Fig. 187.—Larva Bottle.

When the larger species have reached an inch or so in length they should be transferred to a cage of some kind, care being taken not to overcrowd them. The larva cages sold by the dealers are usually square boxes with glass fronts, and pieces of perforated zinc fastened over holes in the sides for ventilation. These, however, need not be bought, for they can be easily made by anyone. A very convenient home for larvæ may also be arranged in an ordinary bell glass. A tin box containing fine mould is first placed in the glass. In this is a small bottle of water for the food-plant, packed as before described with cotton-wool. A little moss is now placed on the mould, and more is heaped round the tin to enable the fallen larvæ to return to their food.

When the larvæ are fully fed they will prepare for their pupal

state, either attaching themselves to the plant, or spinning a cocoon among the moss, or burrowing into the mould. After a short time

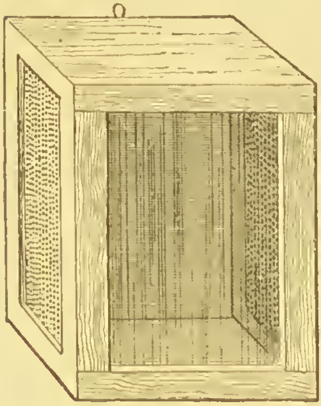

FIG. 188.—LARVA CAGE.

FIG. 189.—LARVA GLASS.

—usually about ten days—the change is complete, and the pupæ may then be carefully removed and dealt with in the manner to be presently described.

Sometimes it happens that the food-plant is close at hand—it may be in the collector's own garden. In such case it is often convenient to rear the larvæ on the growing plant or tree. After placing the larvæ on the leaves, tie up the plant, or a branch of it, in a muslin bag. This method, which is termed *sleeving*, not only prevents the insects from straying away, but also secures them against the fatal attacks of the ichneumons.

Some larvæ have very powerful jaws, and every precaution must be used to prevent their escape from the cage. With such species the ordinary wood larva cage is useless; and, if the bell glass is used, it should be covered with a piece of perforated zinc instead of muslin or leno.

Of course the collector must be prepared to meet with many disappointments during the rearing of his pets. Many will often die during moulting. Sometimes a whole brood will be swept off by the ravages of some infectious disease. A large proportion of the caterpillars brought home will have been 'stung' by the hated ichneumon. But, in spite of all these drawbacks, larva-rearing pays the entomologist well, and the study of the various stages of the *Lepidoptera* is found to be a very fascinating pastime.

A large number of species hibernate throughout the winter in the larval state, and others feed all through the cold months. As a rule the rearing of these from the early stages is rather tedious, and it is better to look out for the more matured forms in the spring.

During the late summer, and still more in the autumn, numbers of full-fed larvæ may be seen creeping down the trunks of trees, or searching round the roots for a suitable spot in which to burrow for their winter quarters. These should always be taken home and placed in a box of mould, where they will immediately conceal themselves to undergo their final changes. They require no attention whatever, and will, in due time, display themselves in all their beauty.

Pupa Hunting

At times when but few larvæ are to be found, and when most of the perfect insects have completed their short term of existence, the entomologist may start out with his trowel and pupa box, and spend a few hours at pupa hunting.

This occupation may be carried on with more or less success all the year round; but it is in the late summer and the autumn that most of the larvæ undergo metamorphosis. If search is to be made for any particular species, it will be necessary to make oneself familiar with its periods; and, after allowing it a week or two to complete its change from the larval to the pupal state, examine the trunk or roots of the tree on which it fed. Most of the larvæ descend during July, August, and September; and, consequently, the most productive season for pupa hunting extends from August to October. Of course the pupæ referred to spend the whole of the winter in their retreats; but they are subject to many dangers, such as floods and heavy rains, and the attacks of field mice and other animals; hence they should be sought as soon as possible after the change is complete.

The only apparatus required by the pupa hunter, besides his trowel, consists of a box similar to that used for larvæ, partially filled with slightly damped moss. If he is heedful concerning his comfort he may also provide himself with a small piece of some waterproof substance on which to kneel while at work.

All kinds of trees and shrubs afford food to a greater or less number of species; so all trees yield more or less pupæ to the collector; but there are certain trees which far surpass many of the others in the number and variety of their residents. The best kinds

are poplars, willow, oak, birch, hawthorn, and elm. Preference should always be given to isolated trees in meadows and parks, and those situated on the banks of streams; and, while the dense portions of woods will probably yield little or nothing to the hunter, the trees on the borders and outskirts are frequently productive.

On reaching a tree, first search the crevices of the bark, especially on the north side. If the bark is loose at any part, insert the trowel and tear off the loose portions, carefully examining both the bark and the wood it covered. Galleries in the wood often reveal the presence of wood-boring species, the pupæ of which may often be seen projecting slightly from a burrow, or lying between the bark and the wood. Mosses and lichens should also be carefully searched.

When you are satisfied with the examination of the trunk, attention may be given to the roots. Examine cautiously any moss, leaves, or any kind of rubbish lying round the roots; for many larvæ spin among such materials. Then remove all this and examine the surface of the ground. Look well into the angles (if any) between the roots, feeling gently with the fingers for cocoons in the cavities which cannot be otherwise examined. All cavities in decayed trunks should be similarly treated, and all the rotten wood lying in the bottom must be taken out and searched.

This having been done, the soil itself must be dealt with. If this is very hard and clayey, you may expect to find nothing; but, if you are likely to go the same round again on some future occasion, you may, by breaking up the ground, prepare a bed which may be appreciated by the larvæ of a later species.

If, however, the soil is dry and friable, the trowel should be inserted a few inches from the roots to a depth of about four inches, and the sod gently lifted up. Great care and patience must now be exercised. The sod should be gently tapped and shaken. It must then be carefully torn asunder. The place from which the sod was removed must also be searched by eye and hand. As a rule the larger number of pupæ will be found in the angles between the roots; but some species—the Poplar Hawk for example—choose the edges rather than the angles.

In nearly all cases the greatest number of finds will occur on the north side of the tree, the natural instinct of the larva leading it to the side on which it is sheltered from rain and sun, both of which are injurious to it.

The Management of Pupæ

Much difference of opinion exists among entomologists as to the management of pupæ, and the advice given by different authorities consequently contains many conflicting statements. The chief difficulty seems to lie in the puzzling problem as to whether the chrysalides should be kept more or less damp, or whether they are best stored in a perfectly dry bed. Of course there is always a certain amount of humidity in the natural soil, and even those pupæ which are concealed in cocoons above the surface of the ground are subject to fluctuations in the amount of moisture in the atmosphere. Many healthy pupæ are to be found in situations which are decidedly damp, if not even wet; and it appears certain that some species actually require to be kept in a moist condition, whether in their natural home or in captivity. Some argue that *all* should be kept moist, but other successful rearers aver that they never damp their pupæ. All things being considered, perhaps the safest plan is to avoid all damping excepting in the few cases where moisture has proved to be absolutely necessary. I have myself tried various experiments in this direction, but cannot claim to have arrived at any satisfactory or conclusive result. I would recommend all beginners who are puzzled by the varying advice offered by those who have each found his own plan to be the best, to divide their pupæ into batches, and experiment for themselves, and then stick to the plan which in their hands gives the best results.

If you wish to try the effects of moisture, proceed as follows: Procure a box of any convenient size. Bore a few large holes in the bottom, and nail over each a piece of wire gauze or perforated zinc. Then put in a layer of gravel, and on this a few inches of sifted mould or cocoa-nut fibre. Let the pupæ lie in the latter, about an inch or so below the surface, and then cover with a layer of moss. Lastly, cover the box with any kind of gauze or perforated material. Stand the box on a few stones or blocks so as to allow free drainage and ventilation, and then apply as much moisture as you think proper. With such an arrangement there is no fear of any accumulation of *stagnant* water; and, we are told, you may 'damp your pupæ with impunity.'

The dry method is much simpler and far less troublesome. All you have to do is to lay the pupæ (perhaps advantageously with their faces downward) on the surface of a thin layer of mould or fibre, and then *leave them alone.*

The inside of the box should be unplaned and quite rough, so that the perfect insects, when they emerge, may easily crawl up to suspend themselves during the drying of their wings.

Those pupæ which are found suspended to parts of plants should be placed in a similar position in the box. This may be done by pinning the part to which they are attached to the side of the box.

Some collectors resort to 'forcing' in order to obtain the perfect insects before their natural time. This may sometimes be a convenience; but, unless the temperature be moderately uniform, this plan gives rise to a number of 'crippled' specimens. Those who are anxious to try the experiment may place the pupa box in a hot-house, or stand it on the chimney shelf of a room where a fire is kept; but in the latter instance it is not necessary that the fire be burning throughout the night. Some even venture to place the pupæ on the top of a cooking stove, but, of course, as far as possible from the fire. This will necessitate a careful watching lest the temperature should rise too high.

If it is intended to rear larvæ from the eggs of any of your forced insects, it is highly probable that in some cases the young caterpillars will be hatched before the food-plant has commenced to bud, and thus the whole brood will be lost.

Preserving Ova, Larvæ, and Pupæ

Many collectors seem to be quite satisfied with possessing the perfect form of butterflies and moths, and make no attempt to preserve specimens illustrative of the earlier stages. The great charm of insect life is the wonderful changes which these creatures undergo; and a cabinet which illustrates their metamorphoses is infinitely more valuable than one which contains the perfect insects only.

Of course the collector can hardly expect to get anything like a complete collection of ova, but such as he can secure may be preserved. Ova to be kept in the cabinet may be killed by a momentary immersion in very hot water, or each one may be pierced with a *very fine* needle. I have also tried shutting them up in a bottle for a long time with some camphor, and find that, treated in this way, they retain their natural form and colour admirably. Where the collector has only a few of a valuable species, he will probably desire to obtain larvæ from the whole. In this case the empty shells may be preserved.

The preservation of larvæ is not nearly so simple a matter, but a *little* skill, combined with more patience, will soon produce some fine specimens. Proceed as follows: Put the larva in the cyanide bottle, where it must remain till quite dead. Now enlarge the anal aperture by thrusting into it a needle, which may be a coarse one for a large larva. Place the larva between two sheets of blotting-paper, and, with a small round ruler or a wide glass tube used after the manner of a rolling-pin, press the contents of the body from head to tail till all have been discharged, and nothing remains but the skin. A blowpipe is now required. This is simply a piece of glass tubing which has been heated in a gas flame and drawn out till the hole is very small. A piece of watch spring is tied on the blowpipe, as shown in our illustration, and a spring clip may be used to prevent the air from flowing back after the inflation of the larval skin. Thrust the point of the blowpipe into the anal orifice, and secure the skin by means of the spring. Now inflate the skin till it just reaches its natural dimensions, but no more, and dry

Fig. 190.—Blowpipe for Blowing Larvæ, fitted with a Spring Clip.

it by holding it some considerable distance above a gas flame. The drying takes only a minute or two in most cases. A small drying oven may be made if preferred. This is simply a metal box, pierced with holes at the sides and top for ventilation, and heated by means of a gas burner beneath.

When dry, the larval skin is carefully removed from the blowpipe, and may then be mounted on a piece of twig, or on an artificial representation of the food-plant.

Many of the larvæ, preserved in this way, retain their colours well, and, when carefully mounted, look as natural as when alive; but others, particularly some of the smooth green caterpillars, lose their natural tints so much that they are scarcely recognisable. Of course these might be painted; but it is hopeless to restore the delicacy of the natural colours by this means. I have found *staining* to be far preferable to painting in some such cases.

Before inflating the skin of a caterpillar, you should make yourself acquainted with its habits, and especially with the position it

assumes when at rest. You will then be enabled to put your specimen in one of its favourite or characteristic attitudes. If the caterpillar is to be mounted with its body bent in any particular way, the skin should be inclosed in a fine wire spiral of the required form while being inflated.

A number of dead pupæ are sure, sooner or later, to become the property of the collector. The larvæ of the ichneumon fly will frequently clear out the contents of a pupal skin, and finally quit its home without leaving any sign of its destructive work, save a small round hole. These empty cases are very useful to illustrate the pupal forms in the cabinet; but, should it be necessary to kill a pupa for this purpose, simply immerse it for a moment in boiling water.

Sufficient has now been said to enable the reader to prepare complete sets—ova, larva, pupa, and imago—for his cabinet; and he may further enrich his collection by the addition of the cocoons constructed by the various larvæ.

Hunting for Beetles

The general characteristics of the *Coleoptera* or Horny-winged insects have already been given, and the common aquatic species have been briefly mentioned; but we have yet to become acquainted with the various kinds of terrestrial beetles, the different modes of capturing them, and also the methods of setting them for the cabinet. As, according to the well-known maxim, we must catch our hare before we cook it, so must we get hold of our beetles before we set them.

But where are we to find them? Experienced collectors tell us 'Everywhere;' and a little careful searching will soon convince us that they are not far wrong. We may start at home, first collecting the species which inhabit our cellars and larders, and then, proceeding to the garden, examine the leaves, the flowers, the barks of trees, and rotten wood. The outhouses may next be searched; and, finally, the heap of decaying leaves and other matter which is being prepared as a dressing to enrich the soil. Straying only a little way from our domicile, we may next, with the kindly assistance of our baker and our provision merchant, secure a few species which have been attracted by the stores of meal and other provisions. Then, extending the field of our labours, let us examine roots, mosses, fungi, gravel pits, and—may we mention it?—dunghills,

the excrement of horses and cattle, and decomposing carcases. Even this is not all, for valuable specimens are sometimes the inhabitants of dark caves; and very rare species have been taken from the stomach of a recently killed toad!

Before starting on the collecting expedition it will be necessary to get together a few pieces of apparatus of a simple character. These should consist of a strong walking stick, to which is fixed a ferrule for the net. This latter must be a strong sweeping net of holland or book muslin, with which to sweep the insects from flowers and herbage. The stick is also used for 'beating' herbs and trees, in which case it will, of course, be necessary to spread a white cloth on the ground beneath. Some entomologists use for this purpose an ordinary umbrella, lined with holland or other light material; but perhaps nothing is better than a yard or so of holland, which will occupy but little space when folded in the pocket or the satchel. An old chisel is very useful for tearing off the loose barks of trees, under which a large variety of beetles seek food and find a home. A garden trowel and a cyanide bottle complete the outfit. The last-named article may be of the ordinary pattern as used for the *Lepidoptera* and other insects, but many prefer a wide-mouthed bottle, half filled with sawdust, among which are one or two pieces of 'cyanide' about the size of a pea. The accompanying figure illustrates a modification of the cyanide bottle which is very convenient. A wide glass tube, ground off obliquely at one end, passes through the cork, and is itself corked. With this arrangement small beetles may be scooped up without allowing those inside to escape; and the large cork is removed only to admit the largest specimens. Some beetles are not easily killed, and have been known to revive after an hour or more in the cyanide bottle. On this account many collectors recommend a momentary immersion in boiling water.

Fig. 191.—Killing Bottle for Beetles.

Many hints have already been given on the *modus operandi* of the beetle collector in our brief enumeration of his implements; a few more remarks, therefore, must suffice. Rotten wood, whether tree stumps or old posts, should always be examined carefully, tear-

ing it to fragments over the spread cloth. Moss, tufts of grass, roots &c. may be similarly treated. If you are so fortunate as to meet with the carcase of a crow, rabbit, or other animal, examine it well. First place it on the white cloth, and immediately inspect its last resting-place, digging into the ground if there are any signs of burrows. Then shake and beat the carcase over the cloth, and you will surely be rewarded for your trouble by the capture of several species of Nature's scavengers. If you see a mass of excrement full of holes, remove it with your trowel, and dig deeply underneath it for the beetles which make their abode directly under their food supply. The excrement itself may be placed in a pond of water, in which case numerous bubbles of air will rise to the surface, often bringing with them beetles of various sizes.

Enough has been said to show that the beetle lover has strange work to do—in fact, we can quite understand the application of such adjectives as 'horrid,' 'disgusting,' 'filthy' &c. in the place of our milder expression. But the entomologist who loves his work—and he who does not is no entomologist at all—thinks nothing of all this. He loves the study of insect life in all its phases, and allows no such trifles to stop his work. Let those who are inclined to bestow on him their pity, rather commend him for his pluck.

Setting the Beetles

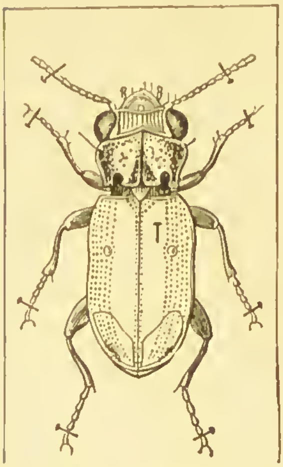

FIG. 192. A BEETLE ON THE SETTING BOARD.

The beetles should be set as soon as possible after capture, or they may 'go bad.' If, however, this is impossible, they may be kept for any length of time in a bottle with a small quantity of spirit.

The setting is performed on a flat sheet of cork, or a flat soft board. The pin is not thrust through the thorax, as with other insects, but through either of the elytra, close to the shoulder. The legs and antennæ are then put in some natural position, and secured by pins till quite dry.

Many of the small beetles are so delicate that even the finest pins would do them serious injury. These should be mounted on card with a very little gum.

In all cases where you possess more than one of any particular species, one should be pinned or gummed on its back so as to display the under surface.

Common British Beetles

Ground Beetles

This, our first group, contains a variety of beetles which burrow into the ground, or hide themselves in crevices in the rocks or the soil. They are known collectively to entomologists as the *Geodephaga*. This word means earth-eaters, but the insects included in the group do not actually eat the soil; they much prefer the dainty morsels which the ground contains.

Fig. 193.—The Green Tiger Beetle.

In dry sandy places we frequently meet with a beautiful golden-green beetle, boldly marked with yellowish spots. Its limbs are

Fig. 194.—The Wood Tiger Beetle (*Cicindela sylvatica*) and Larva.

Fig. 195.—The Shore Tiger Beetle (*C. maritima*) and Larva.

slender and graceful, and its eyes stand out prominently on its rather large head. This is the Green Tiger Beetle (*Cicindela campestris*); and well does it earn its title, for it is as rapacious among its fellow-insects as is the tiger in the jungle. Its jaws are strongly hooked and deeply toothed, so that it takes firm hold of the flesh of its unfortunate victims. When the Green Tiger takes to the wing in bright sunshine, as it frequently does, a brilliant sparkling blue reflection is observed. This has gained for it the name of 'Sparkler,' and is due to light reflected from the bright upper surface of the abdomen when the wings are expanded. The upper surface of the

FIG. 196.—THE VIOLET GROUND BEETLE.

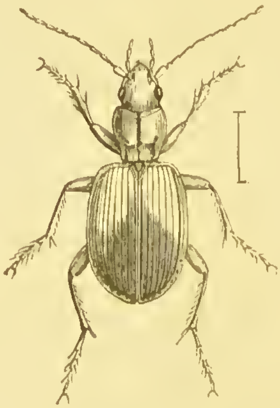

FIG. 197.—THE SUN BEETLE (*Anchomenus dorsalis*), MAGNIFIED.

elytra are comparatively dull when examined with the naked eye; but put the beetle in a strong light, and examine it through a magnifier, and the eye is almost dazzled by the brilliancy of what appears to be a heap of the most gorgeous gems.

There are a few other beetles of the Tiger family, some of which are illustrated, but all are very similar in their structure and habits.

When searching for pupæ at the roots of trees, under stones, or in decayed trunks, you will often meet with the Violet Ground Beetle (*Carabus violaceus*). This is a fine large beetle, to be readily distinguished by the beautiful coppery violet which tinges the edges of the elytra. This insect does not fly. Its elytra are fastened together, and the under wings are not developed. Al-

though it is one of those insects which would be generally included by the ignorant under the disrespectful title 'black beetles,' yet the

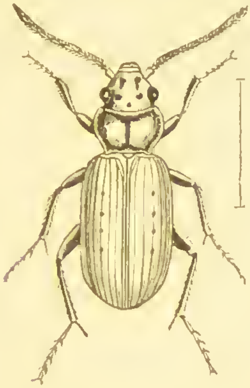

Fig. 198.—Nebria Brevicollis, magnified.

Fig. 199.—The Sunshine, magnified.

Violaceus is *not* black; for a close examination in a good light will reveal a very deep and rich violet tint covering its whole surface.

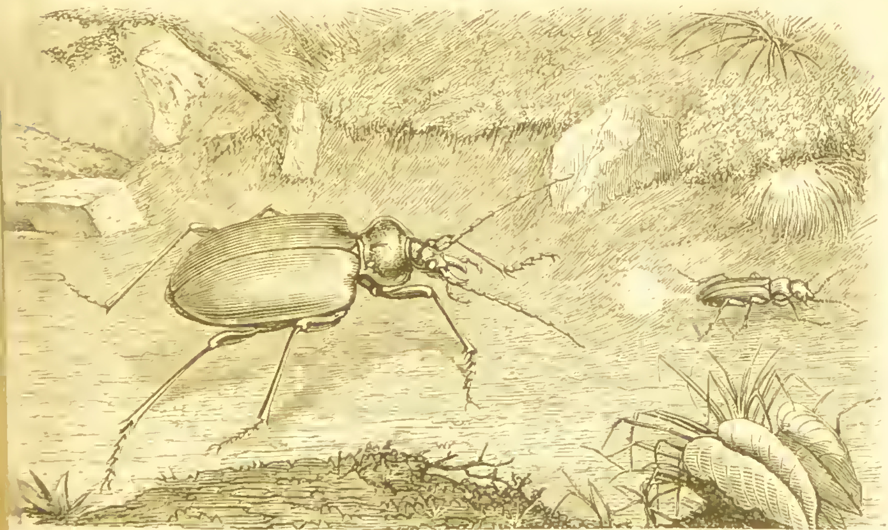

Fig. 200.—The Bombardier Beetle, pursued by a Calosoma.

When disturbed, this beetle, like many others of its family, attempts to defend itself by discharging a disagreeable fluid of a dark colour.

The beautiful little glittering Sun Beetle, so common in wet places, and the short-necked beetle (*Brevicollis*) of the rocky shore, are both near relations of *Violaceus*.

Among the ground beetles we may also mention the Bombardier (*Brachinus crepitans*), and the beautiful Sunshine (*Amara obsoleta*), the destruction of which is said to be a sure cause of stormy weather!

The Bombardier is really an amusing little fellow. When pursued by an enemy, he discharges from the tip of his abdomen a small quantity of a fluid so exceedingly volatile that it immediately vaporises with a slight explosion. The effect on the enemy is ludicrous. He retreats hastily in astonishment; and if, after a second or two, he is bold enough to resume the chase, the Bombardier treats him to a series of his discharges as he makes rapidly for his burrow; but, as the supply of ammunition fails, the force and frequency of the explosions rapidly grow less.

Rove Beetles or Cocktails

During the autumn months, as we are walking along gravel footpaths, we often meet with a curious beetle of a dull black colour, with elevated tail and very short elytra capable of covering only a small portion of its elongated body. This is the interesting (and some would say very ugly) Devil's Coach Horse (*Ocypus olens*), one of the commonest of the Rove Beetles.

It belongs to a family known as the *Brachelytra*, so called on account of the shortness of the elytra of its members.

Although these are so short, yet the wings beneath are large in proportion to the size of the insects—so large that you would think it impossible that they could be so neatly folded into such a small space. You must have noticed that some beetles cannot open their elytra, expand their wings, and start flying with much readiness; but the Rove Beetles take to the wing very rapidly, and, while flying, may easily be mistaken for flies. On alighting, they take considerable pains in neatly folding their wings under the short elytra, which they do with the assistance of the tail bent over the back.

Some of the Cocktails are very predacious and exceedingly fierce; but others are of a quieter disposition, and feed on decaying matter. Some are so very small that their slender bodies seem no thicker than a hair, and a microscope is therefore necessary to enable us to make out the details of their structure.

They all have the peculiar habit before mentioned of elevating their tails when threatened with danger; and some, like *Olens*, are

FIG. 201.—THE DEVIL'S COACH HORSE.

so courageous that they will assume a defiant attitude in the face of their greatest foes. Present the toe of your boot to Mr. *Olens*, and immediately he will open wide his jaws, bend his tail forward over his body, thus exposing the two little vesicles which are ready to discharge a horrid fluid, and challenge you to a combat on the spot. If you take him in your hand he will not be long in convincing you of the power of his curved jaws, and he will also probably treat you to a small quantity—but sufficient though small—of the defensive fluid which has earned for him the name of Olens, or 'stinking.'

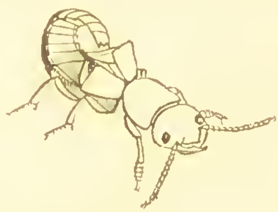

FIG. 202.—A ROVE BEETLE (*Staphylinus*) FOLDING ITS WINGS.

This interesting Cocktail sometimes ventures into our cellars. Its larva is almost as voracious as the perfect insect, but has no wings. It may be dug out of its hole throughout the summer.

The Rove Beetles may be caught almost everywhere. Some live

in holes in the ground; and many are to be met with under leaves and bark. A large number feed on decaying animal and vegetable matter, and these may be easily procured by baiting any spot with

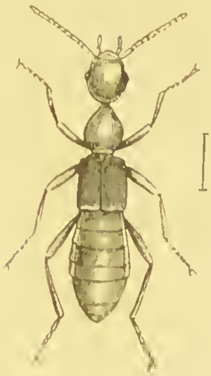

FIG. 203.—THE RED-NECKED ROVE BEETLE, MAGNIFIED.

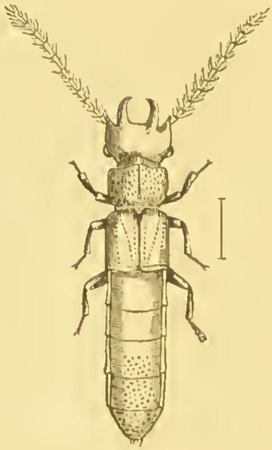

FIG. 204.—THE FOUR-HORNED ROVE BEETLE, MAGNIFIED.

the suitable viands. The larger species may be caught on the wing in a butterfly net; smaller kinds are easily taken in a sweep net; but the best way to capture the very small species is to suspend a

FIG. 205.—ATEMELES EMARGINATUS, MAGNIFIED.

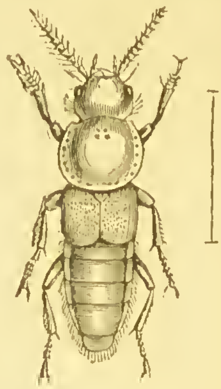

FIG. 206.—QUEDIUS DILATATUS, MAGNIFIED.

sheet of paper, which has been brushed over with gum, in any favourable locality. Fungi should also be examined; for some species are provided with both food and shelter in these plants.

One of the Rove Beetles (*Atemeles emarginatus*) lives in the nests of ants. The ants seem fond of them, and it is probable that these highly intelligent insects derive a nutritious secretion from the Rove Beetles as they do from some Aphides. Another of the beetles of this family—a species of *Quedius*—lives in the nest of the hornet; and since the taking of a hornet's nest is no easy task, these Roves are necessarily rarely captured.

Carrion Beetles

The beetles of this group (*Necrophaga*) are so named from their partiality for decomposing animal substances. They are the scavengers of the ground; and the part they play is a very important one. The carcase of a dead animal, if left untouched on the surface of the ground, soon begins to decompose or decay, charging the surrounding atmosphere with the horrid odours of various poisonous gases. But if any of the Carrion Beetles once get within the range of the attractive vapours, they immediately settle upon the dead animal and do their utmost to convert the putrid mass into a harmless and even useful condition. They commence operations by eating greedily into the rotting carcase, thrusting their heads and even their whole bodies into the crevices as if to enjoy the odour of the luscious feast. Then the females lay their eggs in the remainder, which constitutes a provision store for the coming larvæ.

Carrion Beetles may readily be distinguished from others by the knob at the end of each antenna—they are 'club-horned' beetles. Some of them have short elytra—almost as short as in some of the Rove Beetles, in which case they terminate very abruptly, looking as if they had been cut off square.

One family of the Carrion Beetles—the *Silphidæ*—bury the smaller carcases on which they feed; and are, on this account, commonly known as Burying Beetles or Sextons. One of them, the common Burying Beetle (*Necrophorus humator*), is very plentiful in this country. The best way to secure this and the other Sextons is to bait one or two favourable spots with dead animals, such as frogs, mice, moles, or birds, and visit them at intervals after a few days. But, before catching the insects, let us watch them at their work.

We find that they generally fly about in pairs; and as soon as a couple approach near enough to learn that a dainty meal is not far distant, the female, guided apparently entirely by her sense of smell, makes straight for the feast, and immediately begins to gorge

herself with the appetising repast; but the male hovers round and round in the tainted air before joining his mate, as if to show his delight at the prospect of a glorious feed. When both have had their fill, the male makes preparation for the burial of the remaining store, while the female remains on, or rather *in*, the partly eaten carcase, occasionally appearing on the surface as if to watch the progress of the work. If the spot is a favourable one, the task of

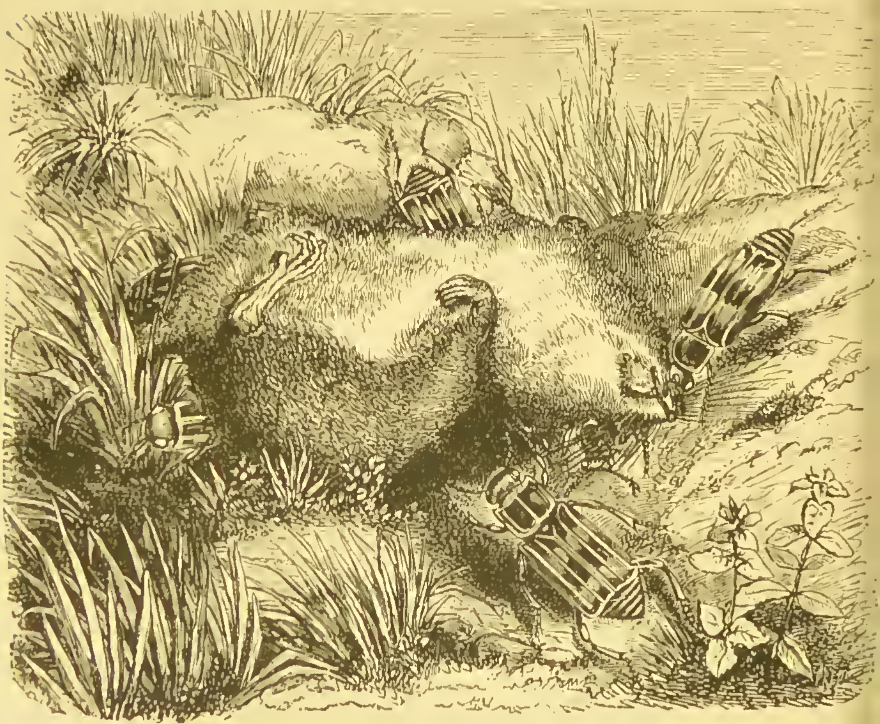

Fig. 207.—Burying Beetles interring the Body of a Rat.

burying commences at once; but if not, the males (for it is not often that the dead body remains the sole property of a single pair) proceed to drag the booty to a suitable place.

This being done, they dig a trench all round, scooping away the soil with their powerful heads, and throwing the débris all on the outer side of the ring. Another furrow is then made in the same way inside the first, and the process repeated till the level is reduced beneath the whole carcase, which then sinks by its own weight, aided by the pulling and tugging of the workmen beneath. Then

comes the filling in of the grave. The males proceed to the surrounding heap of earth, and push it gradually inwards till at last the dead body and the living wives are completely hidden from view. In this subterranean storehouse the females lay their eggs, and leave the coming broods of larvæ to clean the flesh completely from the bones.

Some of the Carrion Beetles (*Histeridæ*) have the habit of feigning death as soon as they are touched or in any way disturbed. They fold their legs and their antennæ close to their bodies, and will allow themselves to suffer serious injury rather than give any evidence of life. On this account they have received the popular name of Mimic Beetles.

FIG. 208.—THE BANDED PILL BEETLE (*Byrrhus fasciatus*), ENLARGED.

The Pill Beetles (*Byrrhidæ*), which derive their popular title from the rounded or pill-like form of their bodies, indulgo in the same form of mimicry. Some of these possess another remarkable feature, which also assists them in evading their enemies: they often rest on stones or on the ground in dusty places; and, as their bodies are covered with a fine downy hair of the same tint as road dust, they are not easily seen.

A passing hint may here be given to the beginner: Some of the Carrion Beetles, especially the *Histeridæ*, have elytra so very hard that the points of the pins used in setting them are almost invariably bent into a hook if we attempt to penetrate them. It is, therefore, advisable to pierce the elytra with a steel point previous to pinning.

Leaf-Horned Beetles or Chafers

The beetles of this group (*Lamellicornes*) have short antennæ, the 'clubs' of which are split up into a number of little leaf-like plates. Their larvæ are soft, white, and fat grubs; so fat, indeed, in proportion to their strength, that they can hardly walk, but drag and roll about in a clumsy manner. These grubs feed chiefly on decaying wood and roots; and when full-grown they construct a cocoon of chips of the same material.

The finest of the chafers is the beautiful 'Stag,' the largest of the British beetles, and known in some parts as the Horn Bug. The Stag seems to be a very common insect in some parts, but very scarce in others. Wimbledon Common is a fine hunting-ground

for them. They may be caught on the wing in the evening, but the net used will require a very long stick. Hunting them out of their hiding-places by day is a quicker method of filling your boxes, providing you know something of their whereabouts.

Our cuts will show that the jaws of the female are much smaller than those of the male; but, if you will try the experiment, I think you will find that the female Stag is the better biter.

Fig. 209.—Male Stag Beetle.

Fig. 210.—Female Stag Beetle.

The larva lives four or five years, and perhaps more, in rotten wood, giving a decided preference to decaying oak. The perfect insect flies about among the branches of trees, and sucks the juices of the young twigs and fruits. In captivity it will feed on sugar, laying its body flat on the surface over which the sugar is spread, so that it may reach it with its tongue.

The common Cockchafer (*Melolontha vulgaris*) is a pretty but destructive insect. The larva feeds on the roots of grasses, and sometimes attacks our potato crops; the perfect insect is a greedy devourer of the leaves of certain trees.

One of the most beautiful of all our beetles is the common Rose Beetle (*Cetonia aurata*), the golden green and burnished coppery

tints of which are hardly to be surpassed. Search should be made for this insect on the blossoms of wild roses, strawberries, and the privet. Its wood-eating larva often finds both home and food

Fig. 211. The Cockchafer.

Fig. 212.—The Rose Beetle.

Fig. 213.—The Dor Beetle.

among the chips and stems of an ants' nest, and has consequently been termed the 'King of the Ants.'

The Dor Beetle (*Geotrupes stercorarius*), also known as the Watchman and the Dumble Dor, is another very common member of this group. The female of this species burrows through a mass of dung, and then perpendicularly into the soil for several inches. She then carries down a store of this nutritious material to support her coming brood through their early days, and completes her labours by depositing her eggs therein.

Among the numerous other Chafers we find space to mention only the Antelope Beetle (*Dorcus*), the common Typhæus which burrows

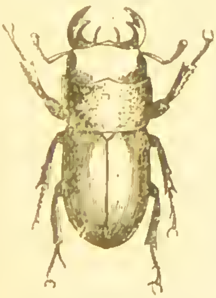

Fig. 214.—The Antelope Beetle.

Fig. 215.—The Common Typhæus.

into sand, and the Brachen Clock (*Phyllopertha*). The last-named insect is called the June Bug in some parts; and its larva is prized by anglers, who use it for bait. They call it the Cockerbundy.

Heteromera

It is a pity that we have no popular name for this group of beetles. The word *Heteromera* means unequal jointed, and is applied to the insects which are just now to be described because the number of joints is not the same in all the six legs.

Perhaps the best known among them is the Oil Beetle, which receives its popular name from its habit of ejecting an oily yellow fluid when handled. It is a wingless and lazy beetle, and its soft body is of a dark blue colour. Let us look into its life-history. The female lays some thousands of tiny eggs in a crevice of the soil on which wild flowers grow abundantly. As soon as the little larva is free it creeps up the stem of some flowering plant, finally settling

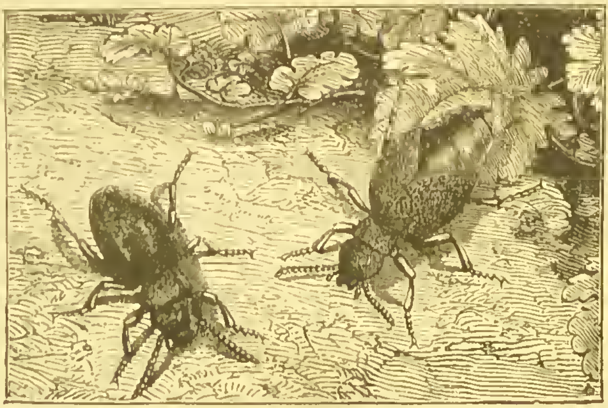

Fig. 216.—Oil Beetle, Male and Female.

in the centre of a flower; and makes a meal of the nectar. But shortly a bee alights on the bloom, and elbows its way between the petals and stamens to reach the same attractive fluid; and while the bee is busily engaged, the little larva clings to it, and thus secures a free and rapid passage to the distant hive. Here it looses its hold, and remains in the new home till it is full fed on the food collected for the larvæ of the hive.

The setting of the Oil Beetle is likely to be somewhat troublesome to a novice, for the soft body shrinks as it dries, entirely losing its natural appearance. This is best remedied by cutting the abdomen completely off, pressing out its contents, and then stuffing it rather tightly with cotton-wool. When this and the other parts of the

beetle are both quite dry, they may be united again with a little gum or coaguline.

This same group includes the lazy and clumsy Churchyard

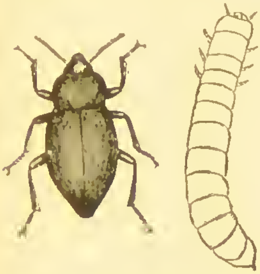

FIG. 217.—THE CHURCHYARD BEETLE.

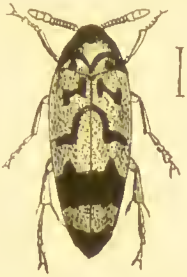

FIG. 218.—THE JUMPER BEETLE, MAGNIFIED.

FIG. 219.—THE CARDINAL BEETLE.

Beetle (*Blaps mortisaga*), which inhabits cellars, churchyards, and other dark and dismal places; the Jumper Beetle (*Archesia undulata*), peculiar on account of the long spines of its legs; the Cardinal Beetle (*Pyrochroa coccinea*), frequently to be found in the sweeping net after striking in flowery herbage; and the Blister Beetle or Spanish Fly (*Lytta vesicatoria*). The last-named insect is a well-known medicinal agent. It contains an irritant fluid, from which a powerful crystalline substance is prepared. This, when applied to the skin, is capable of raising painful blisters. Thin-skinned collectors should not handle these beetles, but move them by means of a pair of forceps.

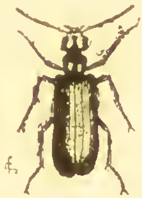

FIG. 220.—THE BLISTER BEETLE.

Soft-skinned Beetles

One of the remarkable features of tropical insect-life is the abundance of luminous species that fill the atmosphere at night with their meteor-like lamps. Conspicuous among these are the shining-tailed beetles (*Lampyridæ*), of which we have only one representative—the Glow-worm (*Lampyris noctiluca*), represented in fig. 221. The female 'worm' is quite wingless, and has no elytra; and she gives a much brighter light than the male. If we examine this interesting insect we find that the phosphorescent light proceeds from the last three segments of the abdomen. It also seems that the lamp is under the control of the insect, for, when disturbed, its luminosity is generally increased. Sometimes, however, the Glow-

worm will put out its lamp when handled. The larva has a retractile and brush-like tail, by means of which it helps itself along. It feeds on snails and slugs, and is said to use its brush for the purpose of clearing these creatures of the slime which covers their skin.

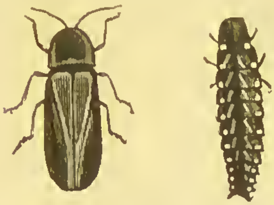

FIG. 221.—THE GLOW-WORM, MALE AND FEMALE.

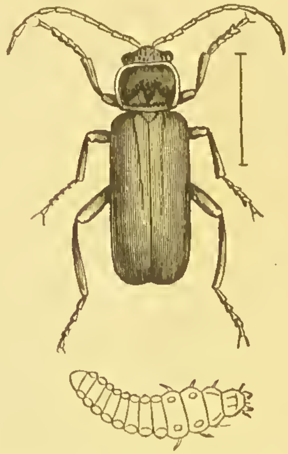

FIG. 222.—SOLDIER BEETLE (*Telephorus fuscus*) AND LARVA.

During the summer months we see clusters of pretty little soft-winged beetles on the flowers of umbelliferous plants. Some of these are red, others are blue; and they are commonly known as Soldiers and Sailors. Their right to these titles is shown not alone by the colour of their uniform, for they are indeed terrific fighters; and boys who are acquainted with their pugnacious habits often amuse themselves by setting them to fight each other. Put a dozen or two of these quarrelsome fellows in a box together, and you will soon find the few survivors surrounded by the fragments of their slaughtered and half-eaten victims. When they are engaged in combat, no respect is paid by either to the colour of the coat, nor is any distinction to be seen in the two sexes; but blues and reds, males and females, all fight indiscriminately, and with no other object than to satisfy their bloodthirsty propensities. One species of this family (*Telephoridæ*) is illustrated, as well as the Hive Beetle (*Clerus apiarius*), whose larva is a parasite on the larva of the hive bee, and the big-bodied Spider Beetle (*Mezium sulcatum*), which are also members of the family of Soft-skinned Beetles.

Before leaving the Soft-skinned Beetles a few words must be said about the dreaded Death Watch (*Anobium*). In *old* houses the

ticking sound produced by this insect may often be heard during the dead of the night, and the belief still exists in some parts that the approach of a death is invariably signalled by this mysterious

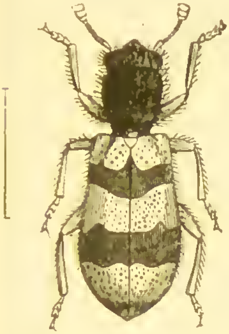

Fig. 223.—The Hive Beetle.

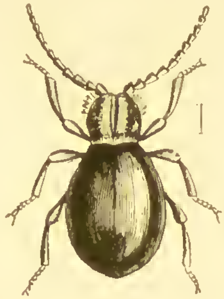

Fig. 224.—The Spider Beetle, magnified.

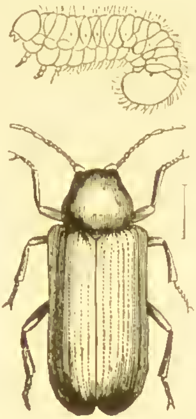

Fig. 225.—The Death Watch and Larva, magnified.

sound. But in reality it is nothing more than the call of a small beetle for its mate. The larva of the Death Watch lives on the wood of old houses and old furniture, which, after its ravages, is said to be worm-eaten.

Long-horned Beetles

Our next group of beetles (*Longicornes*) is characterised by very

Fig. 226.—The Musk Beetle.

Fig. 227.—*Strangalia armata.*

long and slender antennæ. Most of them are beautiful insects, and their larvæ are all wood-borers. Sometimes we meet with trees

which have been completely riddled with the galleries of these destructive grubs.

The beautiful Musk Beetle (*Aromia moschata*) is a well-known example. This insect derives its name from the powerful and pleasing odour which it emits; and it is also known as the Squeaker in some parts, for it produces a rather shrill sound by the friction of one part of its body against another. It is not a very active insect, and may often be seen at rest on the barks of willows, especially the old trees, in the wood of which its larva feeds.

The longest of the 'long horns' exhibited by the British beetles of this group are those of the Timberman Beetle (*Astinomus ædilis*),

Fig. 228.—The Timberman.

a most remarkable insect inhabiting the northern part of our island. Its larva burrows into pine trees.

The other example figured is *Strangalia armata*.

The Weevils

On opening a pod of peas or beans we often find a small circular hole in one or more of the seeds; and if we open the seeds in question we find within each a little white grub. This is almost sure to be a larva of one of the Weevils or Snout-bearing Beetles (*Rhyncophora*) known as the Red-footed Weevil. This little black-headed

grub remains within its excavated seed till it has undergone all its changes.

All the Weevils are more or less destructive in the larval state;

FIG. 229. RED-FOOTED WEEVIL (*Bruchus rufimanus*) AND LARVA, MAGNIFIED.

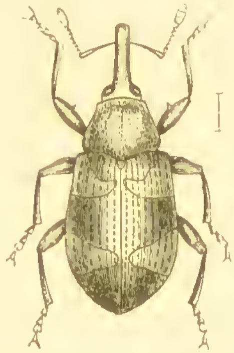

FIG. 230.—THE APPLE WEEVIL, MAGNIFIED.

some, as we have just observed, burrowing into and devouring our pod-seeds; some eating into the very cores of our fruits; and others, again, feeding on rice and other grains.

FIG. 231. THE NUT WEEVIL, MAGNIFIED.

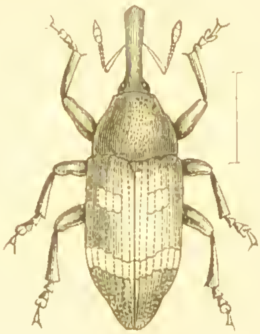

FIG. 232.—THE PINE WEEVIL, MAGNIFIED.

It will be noticed, from the examples figured, that the head of the perfect insect is prolonged into a kind of beak or snout, in the very front of which the mouth is situated.

Some of the Weevils are covered with a delicate layer of scales, which present a most beautiful appearance when viewed through

FIG. 233.—THE OAK WEEVIL, MAGNIFIED.

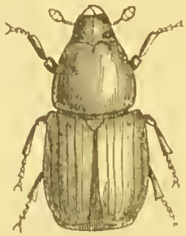

FIG. 234.—THE WOOD-EATING WEEVIL, MAGNIFIED.

the microscope; and care should be taken that these are not rubbed at all, or their appearance will be spoiled.

Vegetarian Beetles

Perhaps we should have headed this division with the word *Phytophaga*, which means 'plant-eater;' but it is probable that the simple English expression will answer all purposes just as well. The group includes many pretty little beetles with short and slender antennæ. They are generally to be easily found, for they all rest by day on their respective food-plants.

Of the commoner species may be mentioned the Asparagus

FIG. 235.—THE TURNIP BEETLE, MAGNIFIED.

FIG. 236.—THE BLOODY-NOSED BEETLE, MAGNIFIED.

Beetle (*Crioceris asparagi*) and the Turnip 'Flea' (*Phyllotreta brassicæ*). The latter causes great damage to our turnips, and

sometimes appears in such vast numbers that whole crops are completely destroyed. The young larvæ are generally hatched while the turnip plants are young and tender, and immediately they burrow into the leaves, eating out galleries in the soft cellular substance, but leaving the outer skin or epidermis intact; thus it is

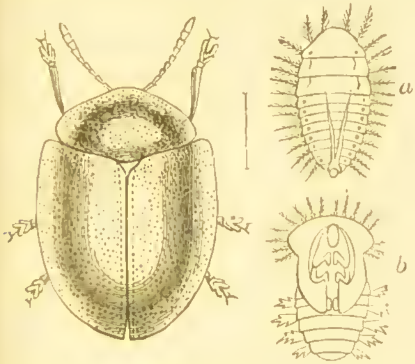

FIG. 237.—THE TORTOISE BEETLE, WITH LARVA (*a*) AND PUPA (*b*).

FIG. 238.—THE RAM-HORNED BEETLE, MAGNIFIED.

often necessary to hold the leaf up to the light in order to detect them.

Illustrations are also given of the Bloody-nosed Beetle (*Timarcha lævigata*), so called because it ejects a blood-red fluid when irritated; the Tortoise Beetle (*Cassida viridis*); and the Ram-horned Beetle (*Crioceris merdigera*).

Ladybirds

These are included in a group called by entomologists the *Pseudotrimera* (a term which means 'false three-joints'), because one of the four joints of each foot is so very small that three only are visible without a microscope.

FIG. 239. THE SEVEN-SPOT LADY-BIRD AND LARVA.

The Ladybirds (*Coccinellidæ*) are all hemispherical in form, being flat underneath, and very convex above. The only means of defence possessed by these pretty little creatures is the discharge of a fluid which has a very disagreeable

odour. The larvæ are very useful in our gardens, for they feed on the Aphides or 'plant lice,' making use of their fore legs to convey the prey to their mouths.

Membrane-winged Insects

We have now reached a group of insects (*Hymenoptera*) which far surpasses all the others in complexity of structure and intelligence. The position which they occupy in the insect world is similar to that held by mankind among the mammals. Many of them are not only gregarious in their habits, but they actually build cities which are capable of containing many hundreds of inhabitants. These cities are well-governed republics, in which each individual has his allotted work. In them we find rulers, soldiers, builders, cowkeepers, nurses, and provision storers, all working with order and industry for the common good; and many a useful lesson has been learnt even by man himself from the wonderful actions of these little creatures.

These insects may readily be distinguished by the four naked membranous wings. They are also provided with strong mandibles, and a mouth adapted for suction.

The group includes Gall-flies, Saw-flies, Ichneumon-flies, Ants, Bees, and Wasps; but we must confine our observations to the last three divisions.

Taking a Wasps' Nest

Everyone is acquainted with the Common Wasp (*Vespa vulgaris*), which pays us frequent visits during the summer months, finding admission through our open windows and doors, and impertinently helping itself, without invitation, to the provisions on our table. Everyone also appears to know that the wasp is armed with a sting; but many do not know that it never attempts to use this weapon unless severely aggravated or in danger. When one of these insects settles on a dish of sweets or other viand in our midst, what a turmoil it causes! Some are so terrified that they hastily retreat, and others more brave than these consider it their duty to end the creature's existence. But a naturalist under the circumstances would prefer letting the wasp alone, not only because he would like to watch the creature's movements—to see what kind of food it prefers, and how it eats; but because he knows that the wasp is very serviceable in reducing the plagues of flies which cause us such annoyance during the hot weather. The Common Wasps

are social insects, living in communities of many hundreds; and we must see them in their common home in order to become fully acquainted with their nature. Let those of my readers who are anxious to study their natural history and their politics accompany me to one of their nests.

We start provided with a trowel, a few squibs containing a good proportion of sulphur, a packet of flowers of sulphur, a sharp knife, a bit of string, and a rather large holland bag. On our way we each cut some birch or other fine twigs, strip off the leaves, and tie them into a small bundle. These bundles are our weapons for both attack and defence.

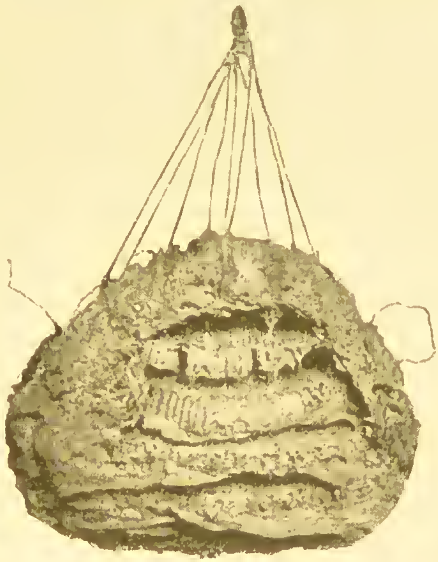

FIG. 240.—A WASPS' NEST.

We have not gone far before we see a hole in a bank or hedge, through which the worker wasps are hastily entering with their burdens and starting off in search of plunder. Here we stand for a short time to watch them, and then search round the spot to ascertain whether the hole we have discovered is the only gateway to the nest. If we find, as we sometimes do, that there are more passages than this one leading from the nest, we proceed at once to stop up the others by throwing on each a handful of wet clayey soil or some other suitable substance. We now light one of our squibs and quickly thrust it well into the hole, of course retreating rapidly as soon as the act is accomplished. One or two of the wasps will often follow you as you retreat after such an assault, but these are easily beaten away with the bunch of twigs. The effect of the sulphur vapour from the squib is to stupefy all the insects that happen to be within, and it will also prevent many, if not all, of those outside from gaining admission; and this latter object may also be assisted by placing some lighted sulphur close to the hole.

We have now to drive off all new arrivals from the nest; and

this is easily done by a vigorous attack with the twigs. A dozen or so of the wasps will be seen flying round the hole, trying in vain to get admission. One at a time we cautiously approach and sweep them off, and if any of the insects follow our retreat they are beaten from us by our comrades. About ten or fifteen minutes of this rather violent exercise will clear the neighbourhood so completely that the work of digging may be commenced; not that the wasps are all killed, for the majority of them are simply frightened away by the whizzing of the fine twigs through the air.

The digging must be carried on with great care, for the nest may be only a few inches beyond the entrance of the passage, and a careless plunge of the trowel may seriously damage our specimen.

At last we reach the nest—a globular and greyish edifice, perhaps much larger than your head, and constructed of a fragile *paper* which the workers manufacture by chewing up sticks and other vegetable substances. As we dig carefully round the nest we find that it is suspended at several points by little projections of a tougher material attached to roots. These are cut with our knife, and the nest thus detached is transferred with all its stupefied inhabitants to our bag, and carried triumphantly home for further examination and experiment.

Immediately on our return we set the glue-pot on the fire, and cut about a dozen pieces of string eight or ten inches long. These strings are glued to the stronger parts of the nest from which it was previously suspended, and by means of them we hang the nest in a box with a small hole at one side and a glass front. We will also cut away a considerable portion of the outer wall with a pair of scissors before finally closing the box.

Now we are right for our observations. The box is placed in a sheltered and convenient spot, and closely watched from time to time. We find the nest to be composed of several storeys, perhaps eight or ten, with just sufficient space between them for the wasps to walk. Each tier or storey is suspended from the one above it by several connectors of strong paper, and each consists of a number of cells with their mouths downwards. Some of the cells are still in course of construction; some are as yet small, and contain a single egg each. Others are of full size, with open mouths, and contain the larvæ in different stages; while others, again, contain the pupæ, and have been closed by the full-fed larvæ just before they changed.

In a day or so the stupefied wasps will begin to revive; numerous

pupæ will also undergo the last change, and the nest will become a scene of the greatest activity. Some of the workers will busy themselves in outdoor excursions in search of food, and will return to feed the limbless larvæ. You will see many engaged in the paper manufacture and the repair and enlargement of the nest. The stingless males will be engaged in cleaning the nest, carefully removing all refuse, and also throwing out the bodies of the dead; for they are the scavengers and the undertakers. These and numerous other operations may be observed, all of which are very interesting to the lover of nature.

Fig. 241.—The Female Wasp.

I once spent some weeks in observing a colony of these insects at work. The nest[1] was taken in Cornwall, and brought to London on the following day. In this case the nest was considerably damaged during the journey by rail, the whole of the bottom and half the side wall having been shaken off. In about a week the whole had been renewed, but the paper made in London was of a dark slate colour, being of necessity manufactured from a different kind of raw material, and this gave rather a peculiar appearance to the nest. I also observed that some of the half-dead larvæ which had fallen from their cells were utilised for feeding their more fortunate brothers.

I have described the taking of a wasps' nest by day, while the insects are all active and on the alert; but it may be taken much more easily during the night when they are inside. For my part I much prefer such employment in broad daylight. The work is certainly harder, and perhaps the chances of a sting or two are greater, but then these are the very circumstances which add to the enjoyment of the chase. I have never had but one sting while thus employed, and that was during the *retaking* of a nest in my own garden under unfavourable circumstances, the nest having become a slight annoyance to our neighbours. The sting of a wasp is a very dreadful affair (excepting to those who have tried one), and if the proposed hunter is really afraid, he can always render himself sting-proof by putting on leggings, thick gloves, a gauze screen over the head, and by tying his sleeves round his wrists.

[1] A photograph of this nest is shown on p. 155.

There are other species of social wasps, some building in holes in the ground and others suspending their nests on trees; and the Hornet (*Vespa crabro*) is a very formidable member of the family.

FIG. 242.—THE FEMALE HORNET.

The taking of a hornets' nest is an undertaking of no mean order. Hornets build in a hollow tree, and much labour with saw

FIG. 243.—THE TREE WASP (*Vespa arborea*) AND NEST.

FIG. 244.—SOLITARY WASP (*Eumenes*) AND NEST.

and chisel is often required to expose it. If you intend to venture the task you may generally rely on several hours' work. Choose a

very dark night, otherwise the hornets will be in and out at their work all the time. Have a friend with you to assist in holding the light and in other little matters. Don't begin till near midnight, and think yourself fortunate if you secure the nest without a sting before sunrise.

We have also solitary wasps (*Eumenidæ*), consisting of males and females only. They build small nests of mud or paper, sometimes under the ground, and sometimes attached to plants. One egg is laid in each cell, a supply of food is introduced for the coming larvæ, and then the nest is deserted for ever by the parent.

Bees

These insects, like the wasps, include both Solitary and Social species; the former consisting of males and females only, and the latter of males, females, and workers.

The Solitary Bee either seeks out a natural home for itself, such as a crevice in a rock, a hole in a tree, or a space among a heap of stones or other débris; or it sets to work to scoop out a burrow in the soil or other soft substance. In each cavity thus selected or

FIG. 245.—THE BURROWING BEE, ENLARGED TO TWICE NATURAL SIZE.

FIG. 246.—THE LEAF-CUTTER BEE, ENLARGED.

made the female lays a single egg, and then proceeds to deposit sufficient food to sustain the larva till it is full grown. This food consists either of pollen or the sweet juices of flowers. When pollen is chosen, it is sometimes kneaded by the insect into a compact ball; and, as to the juices, these are not sucked out of the flowers, but *swept* up by the brush-like tongue of the bee.

One of the Solitary Bees, known as the Leaf-cutter, lines its burrows with pieces of leaves; and another, the Shaver Bee, strips

off the downy covering of certain plants, and binds it together into a kind of cocoon for the protection of its offspring.

Fig. 247.—The Shaver Bee, about twice natural size.

Our wild Social Bees are well known as Humble or Bumble Bees, names which they have earned for themselves by their musical flight. Some persons are of opinion that these bees have no sting. This is certainly true of the males, which are sometimes seen about in large numbers, but does not apply to the other members of the community.

The Moss Humble Bee (*Bumbus muscorum*) may be briefly described as a type of the Bumbles. The female of this species is larger than the male, but the worker is only about half its size. The pairing takes place in the autumn, immediately after which the

Fig. 248.—The Moss Humble Bee and Nest.

male dies; and the female, which is the only one that survives the winter, soon leaves the old nest, and seeks out some snug little nook for her long winter nap. As soon as the spring flowers are well out she awakes from her slumbers, and you may then see her care-

fully surveying a certain patch of ground to find a suitable spot for the establishment of a new colony. As soon as she has chosen the site, she commences scraping out a slight hollow, and then collects pieces of moss or other vegetable material for the construction of a dome. This done, she lines the interior with a kind of wax to

FIG. 249.—THE STONE HUMBLE BEE (FEMALE).

FIG. 250.—THE STONE HUMBLE BEE (WORKER).

render it water-tight, and then proceeds to build her oval cells, using for the purpose a coarse, sticky, brownish wax. After making several such cells she starts out for the purpose of collecting honey and pollen for her future brood. These food materials are kneaded

FIG. 251. THE STONE HUMBLE BEE (MALE).

FIG. 252.—THE HOOP SHAVER BEE (ENLARGED).

into little balls and placed in the cells, into each of which she afterwards deposits about six eggs. The larvæ are soon hatched, and at once attack the food supplied for them. When full grown they spin silken cocoons in which they undergo their changes. The first eggs laid always produce worker bees, and thus the female is supplied

early with builders, nurses, and attendants to look after the wants of the rapidly increasing colony.

The taking of a Humble Bees' nest is no difficult task, for the females and workers do not use their stings as readily as wasps.

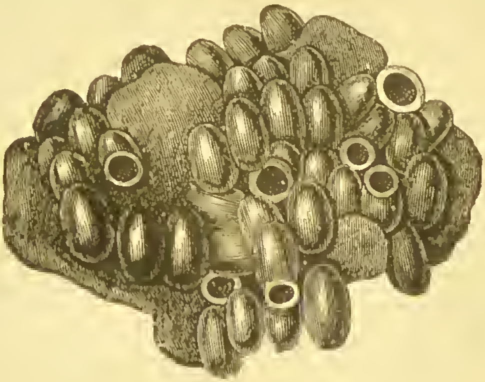

Fig. 253.—Cells from the Nest of the Common Humble Bee.

The common Humble Bee (*Bumbus terrestris*) generally makes its nest in the ground, at a depth of a foot or more; and the Stone Humble Bee (*B. lapidaris*) derives its name from the fact that it often selects a heap of stones for the same purpose.

The Hive Bee (*Apis mellifica*) is so interesting and so important a creature that whole volumes would be required to do it justice; but our present task is so very extensive that we can give but the barest outline of its wonderful history.

Fig. 254.—The Hive Bee (Female).

Fig. 255.—The Hive Bee (Male).

Fig. 256.—The Hive Bee (Worker).

Here, too, we find three kinds—males, workers, and females, or rather female, for only one of the last is permitted to live in the same hive. The workers are 'the people' of the community. They it is who build the city, collect and store the food, nurse the young, and wait on the 'queen.' They may be known, if any distinguish-

ing mark is necessary, by their smaller size, and by the 'palettes' and 'brushes' of the hind legs, with which they collect and carry pollen. The males or drones are stingless, and sluggish in their movements. Their number is only about one-twelfth that of the workers, and they live only a few months. The queen has one duty only—the laying of the eggs. In the hive she is always surrounded by attendant workers, who follow her every movement, but never turn their backs on her. She seldom leaves the hive, and when she does her attendants are still in her presence.

The wax used by the workers in the construction of the cells is not collected ready made, but is secreted by the bees, and little plates of it may sometimes be seen projecting from their 'pockets' —the spaces between the rings of the abdomen. These wax plates are taken by the bee, and are well kneaded in its jaws to render it plastic. The cells are similar in form to those constructed by wasps, but they are arranged in double instead of single layers, two sets of cells being placed with their bases together; or, more correctly, the same base serving for two opposed cells. Also, the cells are horizontal, or nearly so; they slope gently towards their bases, so that they are better adapted to contain the liquid honey.

The honey, too, is not a direct product of the flowers. The bees collect the sweet juices from the blossoms, and then pass them into a little round sac under the fore part of the abdomen. In this 'honey bag' a change takes place, the result being the formation of the true honey with which the cells are stocked; and as each cell becomes filled, it is sealed completely over.

The young bees are fed on compressed pollen, commonly known as bee bread.

Ants

In these wonderful little creatures we meet with the highest intelligence and greatest industry exhibited by insects. One has only to stretch himself out near an 'ant hill' on a hot summer's day, and he will be instructed and amused beyond measure by the varied occupations of the inhabitants of the busy little republic. Let him select, for example, the 'hill' of the common Wood Ant (*Formica rufa*), known also as the Hill Ant or the Horse Ant. Here he will see the busy 'workers' running to and from the nest, keeping well in a certain beaten track. Some are going out in search of food, and others for material for the repair or enlargement of the nest. Then there are those on the return journey, mostly heavily laden with pieces of stick, or with grubs or other insects to feed

their own larvæ. Some may be seen climbing a neighbouring tree, and then returning with *aphides* which are destined to supply them with 'milk.'

Fig. 257.—The Wood Ant (Male).

Fig. 258.—The Wood Ant (Female).

Fig. 259.—The Wood Ant (Worker).

When two ants meet each other on the road, you will often notice that they stop—not for idle gossip, but to discuss some difficulty, or to tell of an accident to one of their community, or to relate good news concerning the discovery of a store of food or a lost relative. After a number of mutual caressings and signs made by means of their antennæ, they both start off in the same direction; and if we watch them we can easily discover the object of their conversation.

It is simply astonishing to see how exceedingly co-operative are all their actions. If an ant finds a fat grub that it cannot carry, it applies for assistance to the first friend it meets, and the appeal is never refused. If a wounded brother is met on the way, one or two will at once proceed to carry it home. And so with the construction and repair of the nest, and with all their work inside the home, every duty is performed with the greatest industry and the sweetest harmony.

Let us now examine the nest closely. We find it to consist of two parts—one underground, and the other, which constitutes the hill, composed of a heap of pieces of stick and other substances, all piled together without cement of any kind. It is on account of this absence of cement that it is almost impossible to examine the chambers and passages without causing much of the material to fall in and fill them up. Still, with great care, the whole arrangement may be studied.

If you damage the upper part of the 'hill' you will see the working ants immediately set about repairing it. Perhaps some of the grubs have been exposed to light; if so, they are immediately picked up and carried to a safer underground chamber. And, if serious damage has been committed, you will probably smell the vinegar-like odour of formic acid which characterises these insects.

But what about the interior? Here also every duty is performed with perfect order and regularity. The female ants, which are larger than the workers, are almost incessantly walking along the various galleries, depositing eggs as they go. Workers are in constant attendance on these highly respected inhabitants, some of them following and caressing their ladyships, while others carry away the eggs to a suitable compartment. Then there remains the feeding, cleaning, and nursing of the young ones, the 'milking' of the aphides, and various other home industries, all conducted in an orderly manner by special detachments.

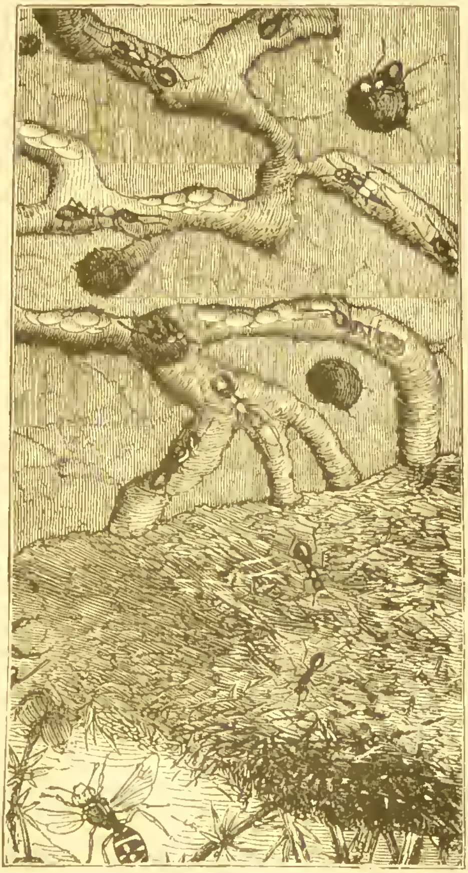

Fig. 260. Portion of the Nest of the Red Ant.

Now let us look briefly into the life-history of the ant. The young larva, as soon as it is hatched, is regularly fed and cleansed by the nurses. It is also moved carefully from place to place as its comfort demands. Sometimes it is brought to the top for a sunning, or it may be moved from one part of the nest to another when a variation of temperature renders such change beneficial. When the larva is full fed it spins for itself a cocoon, and then changes to a pupa which is commonly known as the 'ant egg.' Then, when the time arrives for the final change, the workers assist in the opening of the cocoon.

At about the end of August swarms of male and female ants may be seen *flying* out of the nest. They soon couple in the air,

after which the males immediately perish, and the females either return to their old nest or found new colonies; but, before commencing their domestic duties, they snap off their wings.

Other social ants are common in our country, and among them may be mentioned the rather *sluggish* Black Ant (*Formica fuliginosa*), and the Red Ant (*Formica sanguinea*). This last-named insect is remarkable for its slave-keeping. The workers will invade the nests of other communities of ants, and carry off some of their pupæ. They then care for these just as much as if they were their own offspring; and, when the perfect insects emerge, they make them their slaves.

FIG. 261.—THE BLACK ANT.

FIG. 262.—SOLITARY ANT (*Mutilla Europæa*) (MALE).

FIG. 263.—MUTILLA EUROPÆA (FEMALE).

Some ants, instead of living in communities, are solitary insects. These are not very common in our country, but the one figured is often met with in the New Forest and other localities.

CHAPTER III

THE SEA-SHORE

Up to the present our attention has been directed *mainly* to insects, but now we leave these for a ramble on the sea-shore. Of course there *are* insects to be found there—some of them, indeed, showing a very great preference for the coast, and even venturing far beyond the 'high-water mark' in search of their food. But the commonest of these have already been referred to as fully as our space would permit, and we shall now start out with the object of learning what we can concerning the various animals that are, in the strictest sense of the word, *marine*.

Before we begin collecting these, it will be well to notice one or two features of the coast generally. Everyone who has spent a few hours by the sea has observed the gradual approach and retreat of the water. These motions are spoken of as the Tides, and are the effects of the attraction of the moon and the sun, but principally the former, on the water of the ocean. A few days' observation will also show us that the advance and retreat of the water differs in degree at different times, so that the 'high tide' is much higher at one time than at another; and the same remark also applies to the 'low tide.'

Now, a little consideration will convince you that your chances of securing the greatest variety of specimens, and especially the more uncommon kinds, will be greatest at the time when the receding of the water is at its maximum; for then you can obtain various animals that do not frequent the area between the tide marks excepting where the rocks are only *occasionally* exposed. Therefore every collector of marine life should become thoroughly acquainted with the nature of the tides.

The usual time occupied by each advance and retreat of the water is a little over six hours, so that we get four complete changes

in about twenty-four hours and three-quarters. If, for example, the water reaches its highest level on a certain day at noon, on the following day it will be highest at a few minutes before one o'clock.

Again, we commonly hear of Neap Tides and Spring Tides. The former term is applied when the difference between the high and low water marks is *least*, and the latter when this difference is *greatest*; so that we may describe the Neap Tides as those which do *not* rise very high nor fall very low, and the Spring Tides as those which rise highest and fall lowest.

It is evident from what has been said that a collector should never start equipped for work on the sea-shore without previously satisfying himself with regard to the state of the tidal movements at the time. As a rule he will have no difficulty in obtaining a local 'tide table' from some stationer or news agent in the neighbourhood; and if the table gives no information concerning the 'spring' and 'neap' periods, he must remember that the former—most certainly his best time—occurs about three days after full moon and new moon. Thus we get the spring tides twice in every twenty-eight days; and the neap tides also at corresponding intervals, but about a week later. It should also be known that the change in the nature of the tides is very gradual; so that, should the collector be unable to perform his operations on the *best* day, he should endeavour to do so as near as possible before or after that day.

Most of my readers are probably acquainted with the remarkable variety in the nature of our coasts. Some are so low and marshy that it is almost impossible to say where, in the disputable territory, the domain of the sea terminates. In other cases the coast is well defined, but low and sandy, or muddy. Neither of these is likely to afford much profit to the naturalist. He requires a very rocky coast, where numerous pools are left by the receding tide, and where a number of little caves, crannies, and large detached stones supply the shelter required by the various forms of marine life.

Let us now see what implements we shall require for our work on the shore.

The Collector's Outfit

Perhaps the most essential article of his paraphernalia is the net. This must be, in every respect, very strong. The frame should be constructed of a strip of sheet iron, in which holes are drilled for

fixing the netting. It should not be round, but pointed, and slightly raised on the off side, so that it may be thrust well into the angles of the rocks. The net itself may be made of cord netting, with a very small mesh, and need not be more than a foot deep. The handle should be very tough, and if constructed of two moderately long sticks that can be joined together by a ferrule when necessary, so much the better.

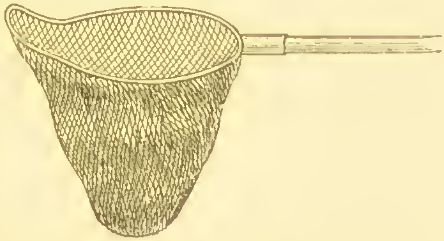

Fig. 264.—Net for collecting at the Seaside.

Of course you will require a satchel, and this should be of a thoroughly waterproof material, or your lower garments will soon become saturated with the drippings from your specimens. The satchel should contain some tin boxes, including one or two of moderate size for the larger specimens; and, if you don't mind the expense, you had better get these made to order to suit your requirements. Let them be *square* rather than round, and of such a size and number that they exactly fill your satchel. You will not then be bothered with the continual capsizing of your boxes and the accumulation of sea water in your satchel. One box at least will be required for crustaceans, one for shells, and another packed with cotton-wool for the more delicate specimens.

You will also require a wide-mouthed bottle, about half filled with spirits of wine, and fitted with a good cork; also a similar bottle filled with fresh water. The object of this is to enable you to kill your specimens as soon as you catch them. Immersion in spirit would accomplish this speedily in all cases, but some of the crustaceans turn red after this treatment, and look just as if they had been boiled; hence it is advisable to kill these by keeping them in fresh water for a short time.

Some marine animals live attached to the rocks, and often hold on so firmly that it is impossible to remove them without injury. For the collection of these you will require a hammer and chisel, so that you may be able to chip off the little pieces of the rock to which they are fixed. This plan is particularly useful when you wish to obtain anemones or other fixed animals alive for your aquarium.

Then, again, you may be desirous of searching for those worms, crustaceans, molluscs, and fishes that burrow into sand. For this

purpose a very large trowel is useful; but if you are 'putting up' very near to your hunting-ground, it will not be much trouble to carry a spade, which will certainly be much more effectual than even a large trowel.

The above apparatus, together with the usual 'knife and bit of string,' will be quite sufficient for all your work on the shore; but a very ambitious collector would require something more than this. A rod and line will prove very useful when one wishes to become acquainted with the fishes of our rocky coasts and river mouths; also a dredging-net if a desire exists to study the inhabitants of

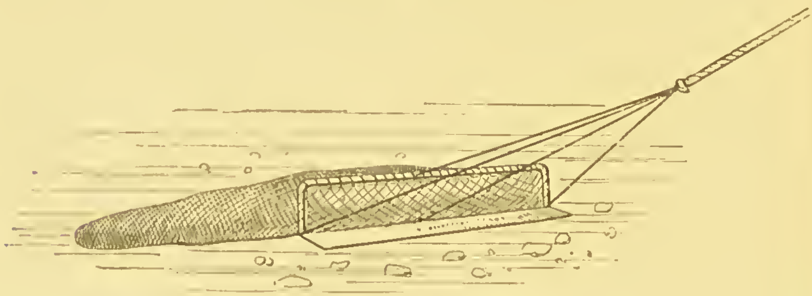

Fig. 265.—The Dredge.

'the deep.' Dredging, however, is rather hard work, and should never be attempted unless at least two persons are working together—one to manage the boat, and the other to look after the dredge.

So much for the outdoor gear. But other materials and pieces of apparatus will be required for your work at home. First, you must prepare store boxes or a cabinet. The latter is not at all necessary. Shallow cardboard boxes, or wood boxes fitted with cardboard trays, will serve all purposes. Each box or tray should be divided into square or oblong cells of different sizes to suit your specimens, or you may fill it with match boxes or little cardboard cells of your own manufacture.

Several wide-mouthed bottles of different sizes will be required. Also some pieces of wire, a few soft boards, pins of various sizes, cotton wool, alum, a little corrosive sublimate, a bottle of gum, a supply of spirits of wine, and some large dishes for the living specimens.

At Work on the Shore

All things being ready, we start off for the shore, arranging our time so that we arrive at the field of action at about 'half-tide,' with the water retreating. Thus we have the best hours of the day before us, and can work continuously for five or six hours should we require it.

First we examine the high-water mark with the object of seeing what the last advancing tide washed ashore. Here we find a quantity of sea-weed, fragments of wood and cork, and various other substances of a very miscellaneous character. As we turn over the weed we see thousands of little sand-hoppers, a few of which we drop into our bottle of water. Here we find also some shells, mostly broken or worn, the egg-case of a skate, the 'shell' of a cuttle-fish, a piece of 'worm-eaten' timber, 'dead men's fingers,' the skull of a gull, a monster jelly-fish, some fragments of beautiful corallines, and numerous other objects, all more or less interesting.

While we have been thus engaged, the waves have been slowly retiring, and a wide hunting-ground is now before us. We make straight for the rocks close to the water's edge. Here we examine the surface of every stone, dip our net into every pool, search the surface of the hanging sea-weeds, and, pushing these aside, carefully look at the rock that lay concealed beneath them. As the water continues to retreat we keep pace with it, searching diligently as we go. Every 'likely' stone is overturned. Its under surface is well scrutinised, as is also the spot from which it was raised. In this part of our work we must be prepared to meet cases of 'protective imitation;' for on these stones we may expect species of crabs, worms &c. tinted and formed in such a manner that detection is sometimes by no means easy; also on the sand or mud beneath there will be various animals whose protective colouring is marvellously deceptive. At last the tide is at its lowest ebb, and now we work for a short time in downright earnest. Here is our opportunity of obtaining the creatures whose zone is strictly *beyond* the tide marks—creatures that either can not or will not submit to exposure unless it be for a very short time only. With our long-handled net we now reach out between the rocks as far as we can, making every endeavour to secure some of the 'rarities' of the sea-shore.

At this stage we carefully examine the sheltered surfaces of

overhanging rocks for sponges and other forms of life, and plunge the net into the various nooks and crannies of the partly exposed rocks. This is our best time for starfishes, many small and fragile species of which we may find under stones of various sizes. Many small fishes are now to be caught—some with the net, and others easily taken in the hand as they endeavour to escape among the stones and weeds.

As the tide flows we are compelled to retrace our steps, but we work as we go, securing fresh captives which were missed as we followed the ebbing waters. Holes in rocks are examined for 'boring shells;' and burrows in the sand call for a sudden plunge of the spade or trowel. In fact, every strange object within our reach is taken for examination. We may not know whether a certain specimen is a plant-like animal or a plant *resembling* an animal; but we *want* to know, so we find room for it in our satchel.

Some of our specimens are to be kept alive for a time so that we may become familiar with their habits. These we pack carefully and loosely among some wet weed in one of our largest boxes. As a rule no water need be added, the moisture and drippings of the sea-weed being quite sufficient to keep the creatures alive for many hours. But if live *fishes* are to be carried any considerable distance, then a rather large 'bait can' containing some sea water is essential.

The animals intended for preservation should be killed on the spot, either by immersion in fresh water or in spirit. They may then be wrapped in soft and delicate sea-weed, and carefully packed in a separate box. In some cases we have to deal with very fragile creatures; and for these also we reserve a special compartment in our satchel, using cotton-wool if necessary as a packing material.

Thus we have finished our day's work as far as *collecting* is concerned, but there remains much to be done at home in the way of housing our live specimens, and setting and preserving our dead objects for the cabinet or store boxes. Before dealing with this subject, however, there are yet one or two suggestions I should like to make suggestions that *may* prove of considerable value to an inexperienced collector. First, then, always avail yourself of any opportunity that may arise of visiting the sea-shore immediately after a storm. For at such times you may expect to find specimens of kinds more or less rare, that have been broken off the rocks or driven from their haunts beyond the tide marks by the furious sea, and then washed ashore by the breakers. Secondly, if you are

staying in or near a fishing village, by all means make friends with the fishermen. Many a specimen, valueless to the fisherman, but of great interest to the naturalist, will find its way into their nets. Take every opportunity of examining their nets as they haul them in; and, if possible, also give an occasional peep into their crab and lobster 'pots.'

Setting and Preserving Marine Objects

I am afraid it will be almost useless to inform anyone who has spent several hours at the seaside collecting that he should see to his specimens *immediately* on arriving home, for the sea air will have worked such a powerful influence on the collector himself that his own urgent needs will demand prompt satisfaction in the form of a 'square meal.' So I put it this way: Immediately after the potent effects of the bracing sea-air have been neutralised by the necessary antidote, turn out all your specimens, and give your first attention to the captures that are still alive. Put these into one or more large and shallow dishes, give them a moderate supply of sea water, and then leave them to themselves while you sort out the dead animals and miscellaneous objects.

All the soft-bodied animals may be put at once into bottles of diluted spirit, and labelled at your leisure. But you must not expect success with all these, and you may consider yourself fortunate if you succeed in preserving a beautiful anemone with all its natural colours, and its tentacles fully expanded; or a *Medusa* with its umbrella and appendages in its natural form. Starfishes may either be preserved in spirit, or suspended in an airy place till perfectly dry.

The *empty* shells you have collected should be washed in fresh water to remove all the salt, and they are then ready for the cabinet; but care should be taken not to retain any damaged or worn specimen unless it be the only one of the kind you possess. There are cases, however, in which the wearing action of the waves brings out the beautiful colours of the shells, and, from an artistic point of view, renders it desirable to retain them. Your most perfect shells will be those which were taken while still inhabited, and these must be very carefully cleared of their contents. The *univalve* molluscs—molluscs with only one shell—should be plunged in boiling water, and kept in this for a minute or so. The body of the animal can then be easily removed with a pin. The horny lid

(the *operculum*) with which the live animal closed its shell should be preserved, and fastened in its proper place by means of a little gum. The bivalve molluscs may be removed from their shells by carefully cutting through the muscular pillars that pass from one side to the other, but the elastic ligament which unites the two valves at the hinge must be kept intact. If you desire to preserve the shell with its valves quite closed, it will be necessary to tie it round with a piece of cotton or fine string, and keep it bound till the ligament is quite dry. Some authors recommend a thorough washing of all shells with the idea of removing traces of vegetable growth from their outer surfaces; but this, I think, is a mistake, for the deposits of confervæ and other low forms of life add much to the natural appearance of the shells.

After the shells are perfectly dry they are ready for the store boxes. The larger ones are simply laid on beds of cotton-wool in the cardboard trays. Small shells had better be gummed on cards, using little wedges of cork, if necessary, to keep them in position while the gum dries. The best gum to use is a mixture of about equal parts of arabic and tragacanth. These materials are dissolved in water, and then about one-fourth the volume of glycerine is added. The use of the glycerine is to give elasticity to the dried gum; without it you will find your shells frequently breaking away from the cards on which they are mounted.

Some of the crustaceans are rather difficult to manage, and will require great care in cleaning and setting. All should have a preliminary washing in fresh water to remove the salt. The small crabs may then be set at once on soft boards or cork, using a liberal supply of pins to keep all the parts in their natural positions, and are ready for mounting on cards as soon as they are *perfectly* dry.

The larger crabs and the lobsters contain so much flesh that, without thorough clearing, they would soon become cases of putrefying matter, creating most unpleasant odours. They should be carefully opened with a sharp knife, of course without cutting *through* any part of the shell.

The whole under shell of crabs, together with the limbs, may be removed bodily; lobsters should be divided by cutting between the thorax and the first joint of the abdomen; the large claws also should be severed. The flesh must now be cleared out with a bent wire or other convenient implement; and the empty shells, after thorough washing, set aside to dry. When quite dry, the severed parts may be fastened together again by means of a little gum or cement.

The bodies of shrimps and prawns may be treated in the same way as lobsters, but require much more care; and after the internal soft portions have been removed, the skin should be stuffed with cotton-wool to prevent contraction on drying.

However carefully the crustaceans may be cleared, there is sure to remain a small amount of animal matter within the hardened skin; and this small residue will always prove an attraction to mites and other museum pests unless some steps be taken to prevent their intrusion. Perhaps the best precaution against such attacks is to sprinkle the interior of the cleared specimens with finely powdered alum, with which a very small quantity of corrosive sublimate has been mixed. The alum will harden the animal matter, and the sublimate, being a deadly poison, will effectually keep out all intruders.

Jelly-fishes

Few objects of our coasts are more common than the large jelly-fishes (*Medusæ*) which may be seen, sometimes in thousands during the summer, gently swimming with the tide, and gracefully contracting and expanding their broad umbrella-like discs. They are almost colourless with the exception of the few (generally four) brightly coloured rings, and their bodies are transparent and almost invisible by day, but some are luminous by night.

The *Medusæ*, at least in their adult stage, are not strictly inhabitants of our shores, for their home is the open sea; but they are so often stranded on our beaches that they are familiar objects to all seaside visitors.

If you attempt to pick up one of these stranded jelly-fishes, your fingers penetrate into its body, and the soft structure breaks away from your grip, falling on the ground in a torn and mangled condition, leaving perhaps a portion of its jelly adhering to your hands. Yet with care you may turn one over, and examine its build without doing it much damage.

In the middle of the under surface is the mouth, surrounded by a number of tentacles which are armed with stinging cells. According to some accounts these armed tentacles are formidable weapons, capable of doing grave injury to the unfortunate bathers who get entangled within their twining grasp. And when we have actually seen living specimens measuring two feet and more in diameter, we naturally feel inclined to accept such dreadful tales. As a matter of fact, however, although the stinging arms of the *Medusa* are

sufficiently powerful to inflict fatal injuries on the smaller animals on which it feeds, yet the effect on even the most tender-skinned

FIG. 266.—RHIZOSTOMA.

FIG. 267.—CHRYSAORA.

bather can scarcely be described as anything more than a peculiar tingling sensation.

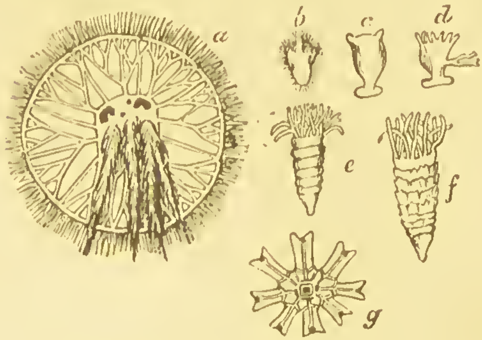

FIG. 268.—MEDUSA AURITA IN ITS DIFFERENT STAGES.

a, Adult form reduced in size: *b* to *g*, earlier stages.

The mouth of the *Medusa* leads to the cavity of the stomach, from which eight or more canals pass off in all directions to the margin of the umbrella, where they all communicate with a circular canal round the rim.

In the case of the *Medusa* we again have a most marvellous history. It is not capable of living in the cold and rough winter seas; so, in the autumn, a number of eggs are produced in the creature's stomach that give rise to smaller animals which can attach

themselves to the rock in sheltered places during the cold weather. At first the young are little freely swimming beings; but, after a time, they settle down on rocks or weeds, and develop into little elongated creatures which may be found during the winter near low-water mark. As the season advances we observe a number of furrows running round the cylindrical body, and these gradually deepen till the whole resembles a pile of saucers. At last the body breaks up through the deepening of the furrows, all the little 'saucers' are set free, and each one develops into an adult *Medusa*.

Equally interesting is the process of artificial division which one may practise on the jelly-fish. If you cut off any part of the body, the lost part is reproduced; and if the body be cut in pieces, each piece will develop into a perfect *Medusa*, providing it contains a portion of the edge of the umbrella, which seems to be the most sensitive and the most vital part of the animal.

Sea Anemones and 'Dead Men's Fingers.'

One of the most beautiful sights in the whole sphere of nature is that afforded by a rocky pool between the tide marks. Stretch yourself out on the rocks and look closely into its calm waters. Here are beautiful little weeds which present to the view most lovely shades of green and purple, and many moving objects displaying a pleasing variety of form and colour. Conspicuous among the animal life of the pond are the beautiful Sea Anemones (*Actiniæ*)—the Sea-flowers of the older naturalists. Their softly tinted cylindrical bodies are surmounted by a large number of tentacles or feelers, arranged in concentric circles round a central mouth. Sometimes these tentacles are fully expanded and perfectly still, as if to increase the resemblance of a flower; but at times they bend gracefully from and towards the centre, setting up feeble currents of water that tend to carry floating particles into the mouth. The tentacles have considerable grasping power—so much so, indeed, that, if a finger be brought within range, they close round it and cling so persistently that the Anemone will suffer them to be torn off rather than loosen its hold.

Would you like to see the Anemone feed? Then hold a shrimp, crab, or other morsel within reach of its tentacles. Soon the struggling creature is literally surrounded with the twining arms. The battle may be a fierce one, but the victory will generally be on the side of the Anemone, even though several of its arms be lost in the fray. At last its prey is quieted, and the process of digestion soon

begins, the animal being drawn completely into the Anemone's stomach if its size permits, but if too large for this, then as far as possible. When digestion is over, the innutritious portions are ejected at the mouth—the only opening in the body save the small pores of the tentacles.

Some of the Anemones, and particularly the *Mesembryanthemum*, may be easily kept in the aquarium. For this purpose they should be removed from the rock with a blunt knife without injury, or, better still, pieces of the rock may be chipped off with the Anemones

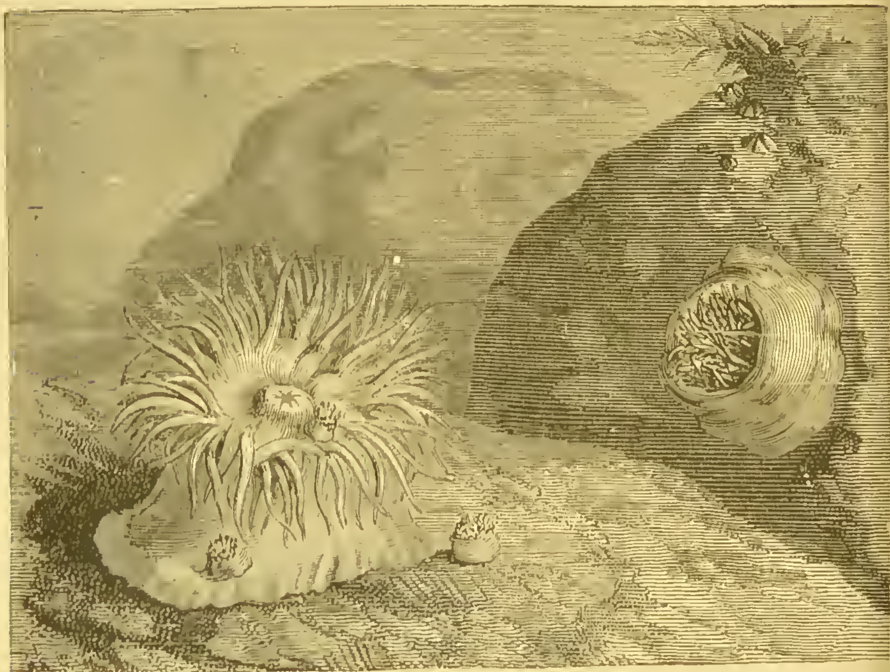

FIG. 269.—ANEMONE (*Mesembryanthemum*).

attached, and conveyed away in wet weed. And very interesting animals they are in the aquarium. Here you may feed them at your leisure; pieces of beef, worms, flies &c. all being accepted greedily. Then its modes of getting about are very varied. Sometimes it crawls about on its disc-like foot after the manner of the snail; but at times it will loosen its hold and float passively away till it reaches a more suitable spot. It will also invert its body, and crawl mouth downwards along the surface of the water—a method very common with water snails.

If your pet Anemones are kept in too close confinement, they will absorb enormous quantities of water in their attempt to obtain the necessary supply of food and oxygen; and if their requirements, thus made known by their swollen bodies, are not satisfied, they will soon die.

The multiplication of some of the Anemones may be well studied in confinement. Occasionally one of them will divide into two, and an interesting example of this mode of increase once came under my notice. I had given one of the creatures a rather large mussel to eat. To my surprise it managed to get the mollusc almost completely into its stomach. But, in a day or two, digestion being over, and the Anemone being unable to rid itself of the cumbersome shell in the ordinary way, it divided its body vertically, and each part became a complete animal, with the almost empty shell standing between them. Whether this division was a voluntary act, or due to the mechanical action of the sharp-edged shell, I will not venture to express an opinion.

But the multiplication of the Anemone usually takes place by the development of eggs which are cast out through the animal's mouth. Like others of the lowly organised creatures, Anemones may also

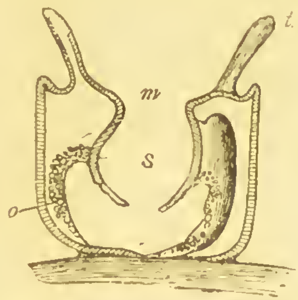

Fig. 270.—Longitudinal Section through a Sea Anemone.

m, mouth; *t*, tentacle; *o*, eggs; *s*, stomach.

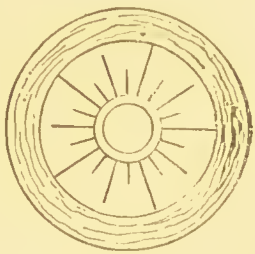

Fig. 271.—Transverse Section.

be increased artificially. If you cut one vertically through the middle, each part develops into a whole. But if the incision be made *across* the body, the upper part will continue to live, and will develop a new 'foot;' but the lower end seldom lives.

If Anemones are collected for examination only, they may be killed by immersion in fresh water; and, after hardening in spirit, sections may be made with a sharp knife or razor.

The reef-building and other Corals of the tropical seas are closely

allied to the Anemones in structure, the chief difference being the deposit of limy matter in the walls of the former. The common *Madrepore* of the Devonshire coasts is a representative of the stony corals. When expanded, its appearance is such that it might be mistaken for an Anemone; but, when touched, its animal portion shrinks away from the stony skeleton, thus exposing a number of

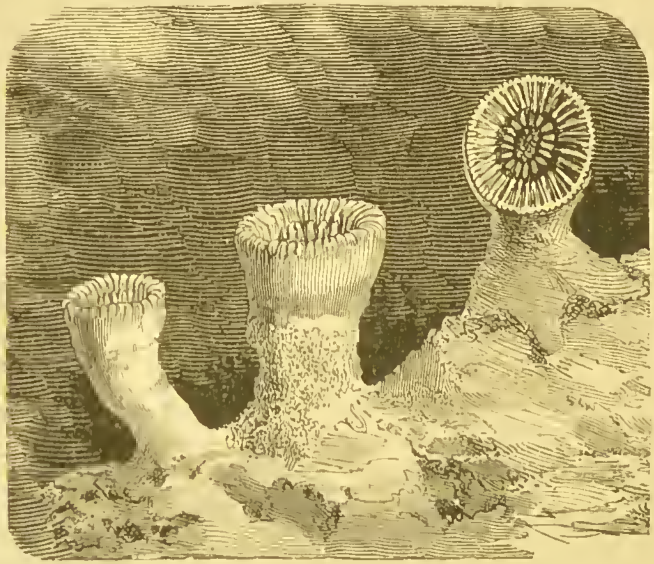

Fig. 272.—The Common Madrepore.

limy plates, all standing on end, and regularly arranged in a radiating manner round the middle of the animal. A strong knife is required to remove one of these Madrepores, for its limy skeleton is built directly on the rock, forming, as it were, an actual part of it, and must therefore be cut through. The Madrepore may be kept in the aquarium for some time, but it is not nearly so hardy as the *Mesembryanthemum* and a few other Anemones.

During our seaside rambles we may come across some ugly and dirty-looking slimy masses projecting from the rocks like so many fingers. So repulsive are they in appearance that they are popularly known as Dead Men's Fingers, or, when of more stubby growth, Dead Men's Toes. 'Ugly,' we have said; but it is doubtful whether *any* living being should be so described; and when this term *is* applied to a living form, it is generally by those who know

not where to look for the beauties. Put the Dead Men's Fingers into your aquarium, or into a clear pool among the rocks, and watch. Shortly a number of beautiful little polyps shoot out on all sides, waving their delicate fringed tentacles in the stimulating water. Each 'finger' is really a little colony of animals, resembling small Anemones, all working together for the general good. All their stomachs communicate with one central cavity, so that the food captured and digested by any one of the community is shared equally by every member. They are not really Anemones, but are so closely allied that we have included them under this head. They are more nearly related to the beautiful Fan and Organ-pipe Corals, and the bright Red Coral of the Mediterranean.

Starfishes and Sea Urchins

The Starfishes, Sea Urchins, and a strange-looking creature known as the Sea Cucumber, all belong to a division of the animal kingdom called the *Echinodermata* or Spiny-skinned animals, from the projections, sometimes short and blunt, and sometimes long and sharp, on the surface. The skin itself is also hardened by the deposit of limy matter, either in the form of a meshwork of delicate spicules, or of a collection of little thin plates. The parts of these animals are all arranged symmetrically round a common centre, just as is the case with the Anemones and Corals; and they possess a nervous system, consisting of a ring-like nerve round the mouth and radiating nerve fibres running from this to the different parts of the body. Another peculiar feature of the *Echinoderms* is the system of water machinery by which they move about. Round the mouth is a ring-like vessel, from which branch several (generally five) tubes in different directions. Then, each *Echinoderm* has a large number of little feet, which are really tubes, connected with the vessels just mentioned.

Now let us see how this machinery is set in action. First, we must know that the whole system—the circular vessel, the radiating vessels, and the tubular feet is filled with water. Having found a live Common Star or 'Five-finger,' put it in a small rock-pool and watch its movements. Presently you will see one or more of its arms extended, and its lower surface placed in contact with a rock or weed. Then the 'head' contracts, forcing sufficient water into the little feet to make them protrude till their suckers are pressed against the surface over which it is to creep. Now the 'head' ex-

pands again, causing the water to be withdrawn by a kind of suction from the feet, which consequently adhere on account of the reduced pressure within. A muscular action follows, by which the body of the Starfish is pulled slightly onward. The progress made by such movements is certainly very slow, but in time the animal will travel a considerable distance.

While your Starfish is thus engaged, turn him suddenly over on his back, and you will then see all the feet in action, each one trying

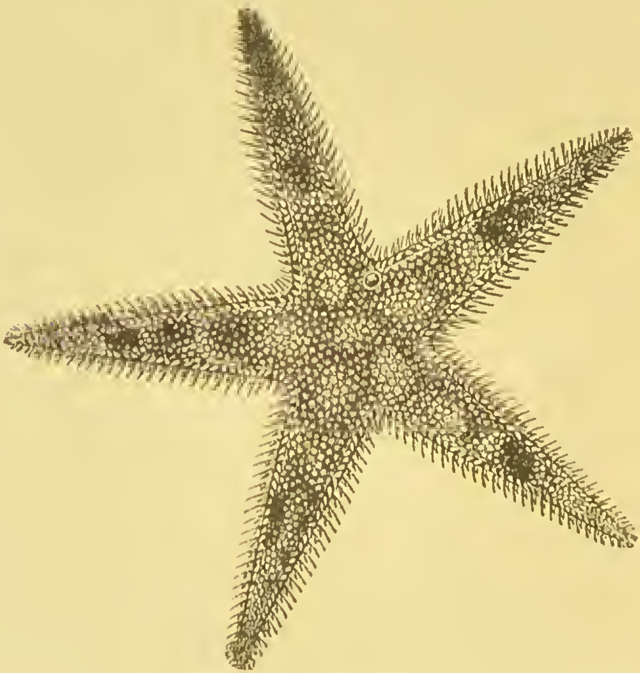

FIG. 273.—THE COMMON STARFISH.

to lay hold of some object. Then you may apply your finger, and so test their sucking power.

These Starfishes are very voracious feeders, and will attack large molluscs. It is said that they inject a poisonous substance between the gaping shells of the molluscs, and then project their stomachs as far as possible between the valves to digest the creature thus killed.

The stomach of the Common Star consists of a pouch within the head, and five long tubes—one running through each of the five arms.

You will often meet with one of these creatures having only four, or perhaps only three arms, the remainder probably lost in combat or accident, or possibly cast off voluntarily during an alarm. When such an event happens, the space left soon closes over, and a new arm or arms will slowly develop to make good the loss.

The skeleton of a Starfish is a very interesting object, and there are two or three ways of getting good specimens. Some recommend giving the job out to the ants. This is certainly very convenient for those living in the neighbourhood of an ants' nest; but the work will require much supervision, or the busy ants will run off with portions of the skeleton before the flesh has all been cleared away,

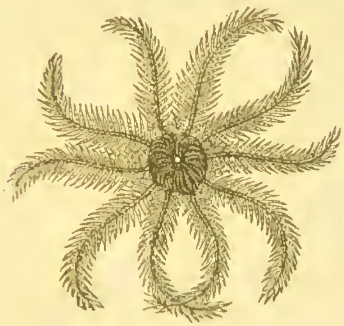

Fig. 274. The Rosy Feather Starfish.

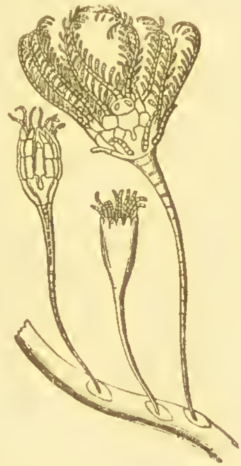

Fig. 275. Early Stages of the Feather Starfish.

even if the 'fish' is shut up in a box with perforations only just large enough to allow an ant to go through. Another plan is to dissolve away all the soft parts in a hot solution of caustic potash; but then the skeleton will require very careful handling while wet.

The Sun Starfish is very similar to the Five-finger, but has twelve *short* rays. The Brittle Starfishes, however, are different in many respects. In these the central disc gives rise to slender snake-like arms, which are jointed, and do not contain branches of the stomach. They derive their popular name from their peculiar habit of snapping off their arms when alarmed. The first time I met with these creatures I collected several, and dropped them into a bottle of spirit; but, on arriving home, I found I had nothing but

fragments! Since that time I have experimented in many ways to get perfect specimens—by no means an easy task, for they often

Fig. 276. The Sun Starfish.

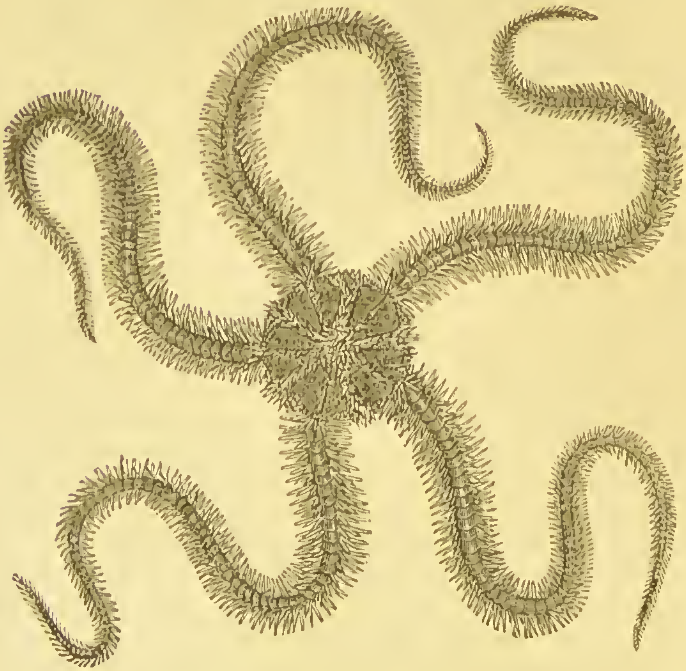

Fig. 277.—The Brittle Star.

break themselves up on the slightest alarm. The most successful plan I have tried is to raise the Starfishes from the pool or stone *as gently as possible*, then place them softly in a box of wet weed, and *gradually* add *fresh* water till they are dead.

Brittle Stars should be searched for under stones at low water, and in pools close to low-water mark.

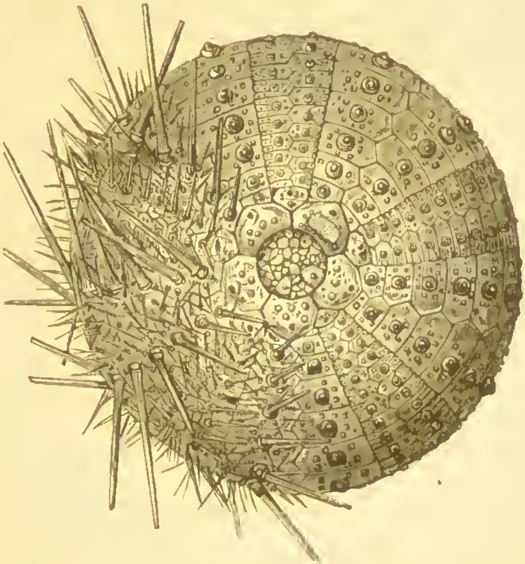

Fig. 278.—Sea Urchin, viewed from above. (Most of the Spines removed.)

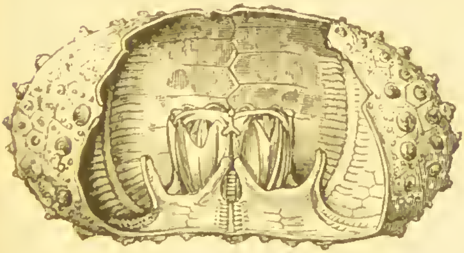

Fig. 279. Interior of the Shell of a Sea Urchin.

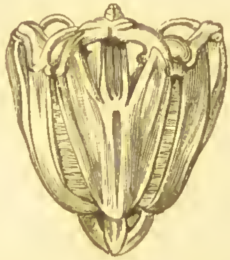

Fig. 280.—Masticating Apparatus of the Sea Urchin.

The Sea Urchin or Sea Egg is certainly very unlike the Starfish in outward appearance, but bears a close resemblance to it in internal structure. Its limy shell consists of five segments, each

perforated with a double row of small holes, through which the tubular feet protrude. It has a system of water vessels almost exactly like that of the Starfish, and its surface is armed with a large number of movable spines. The empty shells that are so frequently washed up on our shores are cleared of the spines and all soft parts, and consequently exhibit the beautiful structure of the shell to perfection. An interesting feature of the Sea Urchin is the complicated arrangement of teeth, consisting of five sets of hard structures set in motion by a complex system of muscles.

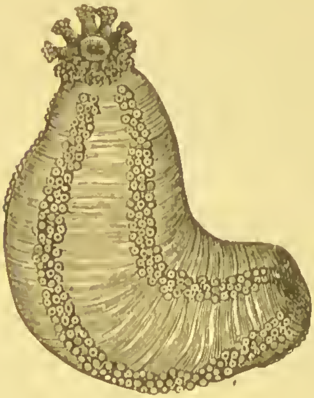
FIG. 281. SEA CUCUMBER.

Another allied animal — the Sea Cucumber—is also common on our shores. It avoids the light, and must be looked for in dark secluded pools close to low-water mark. It may be mistaken at first for a very thick worm, and its fringed tentacles situated at one end of the body may suggest a relationship to the Anemone; but the five rows of sucker feet remind us most vividly of the Starfish and the Urchin, even though it has no spines or hardened skin. The skin, however, is very thick and tough, and contains little limy spicules.

The habits of the Cucumber are very similar to those of Starfishes, and it feeds in a similar manner, protruding its stomach, when necessary, to digest its prey; and it has even been said to entirely dispense with this organ at times, vomiting it completely away, and then remaining without food till a new one has grown.

MARINE WORMS

As we walk over the sandy shore we notice little wormlike objects, twisted up into compact balls or spirals. On touching them they immediately crumble to pieces, for they are composed of nothing but sand. They are the 'casts' of the Lug Worm or Lob Worm, so highly prized by fishermen as bait. We have seen similar 'casts' of earth in our gardens, formed by the common earthworm in exactly the same manner as those on the shore. The Lug Worm burrows by swallowing the sand, and ejecting it at the other extremity of its body; and lines the burrow with a glutinous sub-

stance to prevent the walls from giving way. It is not very pretty at first sight; but, when put into water, the bristles of the fore segments, and the brightly coloured gills of the middle portion, give it a gay appearance. It is often said of this worm that, like the earthworm, if cut into pieces, each piece will become a perfect animal. But this is not so. If a Lug Worm be divided in the middle, both portions die, but the foremost part will retain the power of locomotion for a considerable time.

Fig. 282.—The Lug Worm.

The most interesting of the Marine Worms are those that build themselves dwellings, either of limy substance, or of sand or other particles bound together into a tube. The home of the *Serpula* is one of the commonest objects of the shore. It consists of limy concretions, in the form of white irregular tubes, often found on stones and rocks, and frequently covering the shells of molluscs and crustaceans. As a rule one has no difficulty in obtaining specimens on shells or small stones of suitable size for the aquarium. At first it may be impossible to say whether the tubes are empty, or whether the living *Serpula* is at home; but the point can always be settled by putting the specimen in a rock pool or in the aquarium. It will be some time, however, before the creature will venture to show itself after having been disturbed. But after a time it begins to peep out very slowly, and at last the beautiful red feathery gills are fully displayed. It is not so slow in retreating when alarmed, for then it darts back into its tube with such speed that the eye cannot follow it.

Similar limy tubes are to be met with commonly on the surfaces of the tangles; but these are much smaller, and more uniform in structure. They are always built in the form of a spiral of three turns; and on account of this feature the worm that inhabits them is termed the *Spirorbis*.

Then there are other worms that bind together grains of sand or

small shells, gluing them with a substance obtained from their own bodies. Such are the *Terebella* and the *Sabella*. The tubes constructed by them are rather strong, and will stand much rough handling, for the substance that holds the particles together becomes

FIG. 283.—TUBE-BUILDING WORMS: *Terebella* (LEFT), *Serpula* (MIDDLE), *Sabella* (RIGHT).

a tough membrane. Sometimes we see single tubes cast up by the waves, but at others a large number are seen bound together on the surface of the rock into such a compact mass that a hammer is necessary for removing a cluster of them.

If an animal is termed a Worm, the name naturally recalls to our minds the most familiar of the worms—the common earthworm; and we naturally expect that the creature so designated will closely resemble our familiar friend in general form and habits. But this is not so, for many of the so-called worms are so constructed that no one but the naturalist would ever dream of anything like a close relationship. This is certainly the case with the Sea Mouse, for it is decidedly more like a mouse than a worm in outward appearance. But animals are classified according to internal structure rather than general form. The Sea Mouse is not seen very commonly on the shore except by those who know where to look for it, as it frequents the sheltered and muddy places close to or beyond the low spring water-mark; generally hiding under stones, or resting on mud in rather dark corners between the rocks. Its body is oval.

Fig. 284.—The Sea Mouse.

and flattened beneath; and the lower margin is thickly covered with hairs that exhibit the most beautiful iridescent hues. These exquisite colours are not at all impaired by spirit, for specimens that I have preserved in this fluid for many years are still as beautifully tinted as when they were captured.

It is very remarkable that a creature like this, capable of showing itself to the greatest advantage only in a strong light, should seek the darkest crannies of the shore. Even when it *does* expose itself to light, it generally creeps along the mud with its iridescent hairs buried, and at the same time, the fine mud that settles between the short hairs on its back renders it a very inconspicuous object. If you place a Sea Mouse in the aquarium, it will generally lie concealed among the stones and weed, sometimes creeping about with a sluggish motion; but occasionally it will swim actively for a short time.

In our seaside wanderings we sometimes meet with very peculiar objects resembling little leathery bags or bottles, either attached to stones in rather muddy places, or resting on the mud itself. At first sight we can hardly decide whether they belong to the animal or the vegetable world, and we inquisitively handle them when the bags, suddenly contracting, eject a quantity of water over us. These strange creatures are Sea Squirts, not very wormlike in appearance, yet sometimes grouped with the worms; by many, however, they are considered to be more closely allied to the molluscs.

Fig. 285. - Sea Squirt.

Numbers of these creatures are often found in the estuaries of rivers, at times being so abundant that they become an annoyance to the trawlers by almost filling their nets. If you watch a Squirt in the aquarium you will notice that its body has openings or 'syphons;' and by means of these a constant current of water is set up for purposes of respiration and food-collecting, the water entering by one and leaving by another.

Shells of the Sea-Shore

A few hints have already been given concerning the collecting of shells, and also on the preservation and mounting of the specimens; but it is essential that the reader should know something of the

general characteristics of the inhabitants of those shells, and the broad features of their classification, so that his collection, instead of being a confused mass of mixed and unnamed objects, may consist of a properly classified series of specimens, representing the natural history of the molluscs, and forming a permanent museum for reference and study. With this object in view we shall briefly notice the principal families of the British molluscs in turn, so that our young shell gatherers, following the classification used, may intelligently arrange their specimens.

The terms 'shell' and 'shell-fish' are generally used in a very indefinite manner, the former being applied equally to the shells of molluscs and the hardened skins of crustaceans, and the latter, as a consequence, used to designate animals of both these important divisions of the animal creation. But we shall, for the present, confine our attention to the Mollusca, leaving the crustaceans to be considered by themselves in our next chapter.

Bivalve Molluscs and their Shells

The reader will probably remember the fresh-water bivalve—the Anodon—which was briefly described in connection with Pond Life.

FIG. 286.—THE SHIPWORM.

Now, this creature may be taken as a type of the class of the molluscs with which we shall start. This class has been variously

named, and several of the terms are still retained. Thus, we find it headed with the formidable name *Lamellibranchiata*, because all its species possess gills arranged in layers. It is also called *Acephala*, as the creatures included have no heads; and *Conchifera*, which means 'shell-bearing.'

The chief distinguishing features of these Bivalves, including the

FIG. 287.—PHOLAS DACTYLUS.

general character of the shell, the arrangement of the two lobes of the mantle, and the two syphons for the circulation of water, have already been mentioned in dealing with the Fresh-water Mussel, and need not be repeated here; so we shall at once deal with the numerous important families.

First we will take the Boring Molluscs—those that bore into hard substances, thus securing for themselves a greater protection

Plate VI

than is afforded by their small or fragile shells. In this family (*Pholadidæ*) we have the 'Ship-worm'—not a worm, of course, but a wormlike mollusc with two small and imperfectly formed shells at its fore extremity. They burrow into submerged timber, and often do immense damage. The Pholas or Piddocks have very fragile shells that gape permanently at both ends, and are sculptured on the outer surface so that they look like a rasp. These creatures bore regular holes, two or three inches deep, in hard rocks. If their shells were strong and hard, we could quite understand how, by a continual rotatory motion, they could form these burrows; but, with no other implements than a very fragile shell and a soft foot, the explanation is not at all simple. Some naturalists have supposed that either chemical or electrical action or both are concerned, while other observers have suggested that the shell, delicate as it is, constitutes the boring tool. But it is now generally admitted that the foot itself, by a perpetual rotation, does the chief part of the work.

The Gapers (*Myacidæ*) are not the only bivalves that have a right to the name, for all the shells yet named gape more or less. The commonest of these is the Old Maid or Common Gaper (Plate VII), which is used for food in some parts. *Thracia papyracea* belongs to the same family.

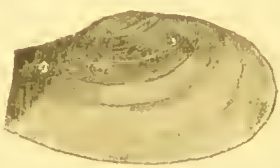

Fig. 288.
Thracia papyracea.

No one could possibly mistake the 'Razors' (*Solenidæ*) with their long and narrow shells gaping at the two extremities. The feet of these bivalves are large and powerful, and very effectual in burrowing into sand. Many Razor shells are washed up on our shores but an attempt should always be made to secure tenanted specimens, both to get a glimpse of the animal, and also to secure the shells in perfect condition. As you walk over a sandy beach at low tide you may see the holes of the Solens' burrows. But they are very deep—so deep that a spade may fail to turn them out without injury. You must resort to stratagem. Throw a little salt into a burrow. This will cause the Solen to rise to the surface; and then a *sharp* plunge of the spade will secure it. If, however, your plunge is weak and undecided, Mr. Solen will retreat with the speed of a dart to the bottom of his sandy home. Fishermen use this mollusc largely for bait, but they generally obtain it by means of a strong hooked wire. They suddenly thrust the hook down the burrow, so

that it enters the gaping end of the shell. Of course the Solen then closes its shell as tightly as possible on the intruder, but this only gives the hook a better hold. The implement is then turned round a bit, and pulled out with the shell-fish secure. This mode of capture is all very well for the fisherman, but for the naturalist it will not do, since it damages the animal, and frequently also the shell.

Fig. 289.—*Tellina crassa.* The Blunt Tellen.

There are several common species of Razor shell-fish, and all of them are good eating; but it is seldom that they are found in our markets.

The beautiful shells of the Tellens are known to every seaside visitor. They are common everywhere on sandy shores, sometimes being thrown up by the waves in thousands. Their colours are very rich but variable, and consist generally of delicate pink and orange tints. The Tellens are burrowers in the sand, and in some cases the shells are very fragile. The Sunset shells and the Wedge shells belong to the same family (see Plate VII).

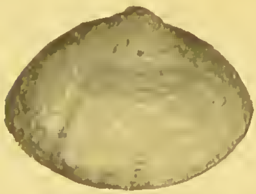

Fig. 290.—The Radiated Trough Shell (*Mactra stultorum*).

Fig. 291.—Venus Casina.

Fig. 292.—Venus Exoleta.

Several interesting families of bivalves we must pass over with no more than a bare mention of their names, leaving the figures of representative shells to speak for themselves.

Fig. 290 is one of the Trough shells (*Mactridæ*) of sandy shores. The Venus shells (figs. 291 and 292) and the Tapestry shells (*Tapes*, Plates VI and VII) are members of the family *Veneridæ*.

Plate VII

Both the Heart Cockle and the Astarte shells (Plate VI) are remarkable for the beautiful structure of the hinge.

There is a family (*Arcadæ*) having shells which resemble miniature Noah's Arks, and among these are the Ark shells and the Nut shells. The former are found chiefly in warm seas, but those figured are British species.

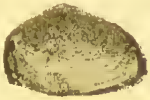

Fig. 293.—Ark Shell (*Arca lactea*).

Fig. 294.—Nut Shell (*Nucula nucleus*).

The 'Noah's Ark' is not generally well known, but may be found under stones and in the dark crevices of rocks just beyond low-water mark. The Nut shell is not often obtained without the use of a dredge.

The *Mytilidæ* or Mussels (Plate VII) form a very important group, and include the edible Mussel so largely used as food. Many of them anchor themselves to rocks and timber work by means of a silken cable known as the *byssus*, and some are so plentiful and so truly gregarious that they entirely cover immense masses of rock. It has been observed that these social Mussels afford great protection to structures exposed to the force of the waves and strong tides, so much so that they have even been made use of for this purpose, notably in the case of a bridge over the Taw at Bideford. The piers of this bridge were constantly under repair before Mussels were brought to protect them, but afterwards required very little attention.

The edible Mussels are really a very important article of food, but at times they develop poisonous properties that lead to serious results. And although the subject has received much attention from experts, yet the cause and seat of the poison are not known. Some have stated that the injurious effects of eating these dainties arise only from those which have been removed from the copper sheathing of ships, and others have declared that the byssus is the seat of the poison. But it is more probable that some unknown and infectious disease to which the molluscs are occasionally subject is the real cause.

The Horse Mussel (*Modiola*) has a very strong byssus, and is common on our shores, where it burrows into the sand or mud. The Chambered Mussel is an immigrant to our country, having been brought to our ports attached to the bottoms of ships. After being scraped off in the docks, these Mussels settle down and multiply in

their new home, spreading rapidly along our shores and up our river mouths.

The Wing shells are so called from the 'wings' that project from the hinge of the shell. This family includes the interesting Pinna, very common on our southern shores, and especially the Cornish coast. The byssus of this mollusc is very fine and silky, and has been woven into gloves and other small articles of dress. Its shell is the largest of all our British molluscs, often measuring more than a foot in length.

Everyone is familiar with the common Scallop, so often seen on

FIG. 295.—PINNA RUDIS.

FIG. 296. THE SADDLE OYSTER (*Anomia ephippium*).

the fishmonger's stall, and known locally on the south-west coast as the Frill and the Queen. It represents an extensive family (*Pectenidæ*) characterised by a fan-shaped shell, boldly marked with radiating ribs, and often beautifully coloured with various shades of red and yellow. The young Pectens swim about rapidly by alternately opening and closing their valves; but the aged are less active, and settle at the bottom below the tide marks, where they may be secured by means of the dredge. The bodies of these molluscs are conspicuously coloured with bright orange or scarlet, and the fringe of the mantle is bordered with numerous black eyes. The *Limas*, known also as the File shells, belong to the Pecten family.

Our last family of the bivalves—the *Ostreæ*—includes the Oysters, of which the common edible species exhibits as much variation in structure as do the different breeds of dogs. This highly valued mollusc takes five or six years to reach its prime, and feeds on the minutest forms of marine life. It cannot exist in sandy places, for the sand gets between the parts of the hinge, preventing the oyster from closing its valves, and thus it is eventually smothered with sand. It 'spawns' in the summer, and the 'spat,' which resembles slate dust, and is formed of five or six million eggs, is ejected in clouds. The young Oysters are active creatures, and are provided with swimming organs which they use freely.

Univalves, or One-shelled Molluscs

We have now to glance at a higher division of the Mollusca, known as the *Cephalophora* or Head-bearers. These have distinct heads, with eyes and horns or feelers; but we need not enlarge on their structure now, for they have been previously briefly described in connection with our Fresh-water Snails.

Among the least perfect of these are the *Dentaliadæ*, or Tooth or Tusk shell-fish, which are named from the resemblance of the shells to the elephant's tusk. These shells are conical, and open at both ends; but it is interesting to note that, in their earliest stage, the *Dentaliadæ* are bivalves. The creatures are quite inclosed in the mantle, and the body is attached to the shell near the smaller end. Their heads are not perfectly formed, and they have no eyes or feelers.

Fig. 297.—The Grooved Tusk Shell (*Dentalium entalis*).

The largest and most important division of the univalve molluscs is the *Gasteropoda*, or Belly-footed, of which the Limpets and Whelks form typical representatives.

The common Limpet is so well known, so easily obtained, and so hardy in confinement, that it forms a very interesting aquarium pet. On all our rocky coasts these creatures are seen in thousands between the tide marks. While they are exposed to air they remain perfectly still, with their conical shells closely applied to the surface of the rock. But if you take the Limpet by surprise, suddenly

thrusting it aside with a stick, or quickly lifting its shell with a blunt knife, you may detach it with ease; if the Limpet, however, is warned of the approaching attack, it is surprising with what force it will adhere. In order to see how it secures itself so firmly we will watch one of the Limpets in our aquarium as it crawls over the glass. Here it is, with shell raised, and 'horns' extended, gliding gracefully along by the wave-like contractions of its muscular foot. Tap it very gently on the shell, and immediately it tucks in its head, pulls its horns inside, and brings its shell close to the glass. Another tap on its back, and the foot contracts still more, closely adhering by the rim, but arched away from the glass in the centre. In this way it produces a vacuum under its body, and any attempt to lift it from its seat is useless unless sufficient force be applied to overcome the atmospheric pressure outside. If you examine the inside of an empty Limpet shell you will see the scars which mark the position of the powerful muscles that so effectually overcome the pressure of the air.

Limpets are not what we should term active creatures, and they sometimes remain in one spot so long that their shells become exactly adapted to the surface of the rock, and we also often find the rock hollowed out beneath them, probably by the almost continuous action of their feet. As another result of their sedentary habits we see green and purple weeds, corallines, and acorn barnacles flourishing on their backs, often in such profusion that the shell of the Limpet is entirely concealed.

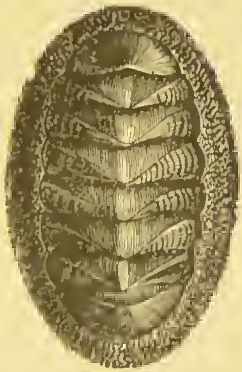

Fig. 298.—The Chiton or Mail Shell.

The long ribbon or 'tongue' is armed with between one and two thousand teeth, and is a very interesting object for the microscope.

The Chitons, or Mail shell-fish, are very near relatives of the Limpet, but the protective covering consists of eight jointed plates—a veritable coat of mail, with its segments so arranged that the Chiton can roll itself up into a ball like a woodlouse.

The Top shells (*Trochus*) are named from their resemblance to the toy top. Some species are exceedingly plentiful on our shores, and are often washed up in large numbers; but the living specimens may be found on rocks and weeds at low tide. Like the Limpets,

Tops have well-developed 'tongues,' and the little teeth are so arranged that they form a most perfect file. They are very useful in the aquarium, as they help to keep the glass free from low vegetable growth.

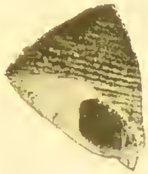

FIG. 299.—THE GREY TOP (*Trochus cinereus*). (SEE ALSO PLATE VII.)

FIG. 300.—TOWER SHELL (*Turritella*).

FIG. 301.—SECTION OF A TOWER SHELL.

The common Periwinkle needs no description. It is by no means a very ornamental mollusc, but it is interesting in the aquarium, being very hardy in confinement, and also a useful scavenger.

FIG. 302.—THE LADDER SHELL (*Scalaria communis*).

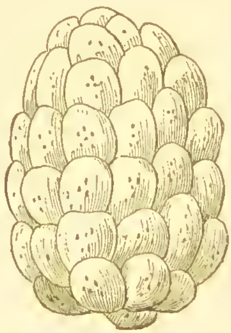

FIG. 303.—EGGS OF THE WHELK.

The Turret or Tower shells are of a more fragile character, and consequently the greater number of the specimens washed up by the waves are more or less damaged.

The Wentletraps or Ladder shells (*Scalaridæ*) may be known

by the bold ribs that run across the whorls. They are white shells, and the molluscs inhabiting them are predacious.

The Whelks form a very extensive group, and they are all of predacious habits. Some even bore holes through the shells of other molluscs and then devour them. The Dog Periwinkle (Plate VII) is remarkable as having supplied the famous purple dye largely used by the ancients. With a little patience you can easily succeed in procuring some of this peculiar substance. Your best plan will be to break the shells and get the animals out entire. You will then see a vessel containing a small quantity of a yellowish liquid. Now expose this to a strong light, and it will gradually turn, first green, then blue, and lastly purple.

'*Head-footed*' *Molluscs*

There is yet another division of the Mollusca, known as the *Cephalopoda* or Head-footed molluscs. They are so named because

Fig. 304.—The Common Octopus.

they have a number of 'arms' or, if you prefer it, 'feet' surrounding the mouth. Not many of these creatures are to be found on our shores, but they include some 'sea monsters' with whose general characteristics we are all familiar. Take the common Octopus as a type. Its large staring eyes that never close, and its eight long and powerful sucker-bearing arms, are calculated to arouse the strongest interest and excitement.

The Cuttlefish is not very often seen on our shores, but its 'bone' is a familiar object to all seaside frequenters. It is in

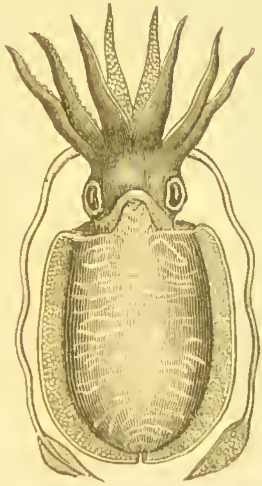

FIG. 305.—THE SEPIA OR CUTTLEFISH.

FIG. 306.—'BONE' OF THE CUTTLEFISH.

reality not a bone at all, but an oval and very light mass of chalk arranged in layers on a harder support. The eggs of the Cuttle are also to be seen at times on the shore. They are dark oval bodies,

FIG. 307.—EGGS OF THE CUTTLEFISH.

joined together or attached to weed by short stalks, and are commonly known as Sea Grapes.

The Common Squid is very plentiful on our shores, and is often used by fishermen as bait. Its 'bone,' which is generally less than

two inches long, is not chalky like that of the Cuttle, but composed of a horny material. Another allied creature is the pretty little

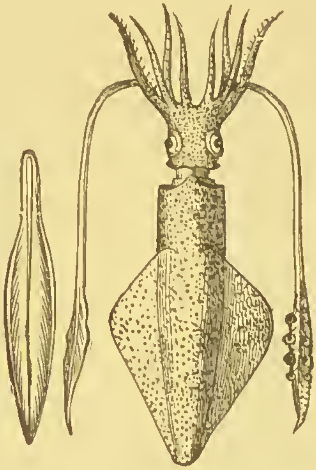

Fig. 308.—The Common Squid (*Loligo vulgaris*) and its 'Pen.'

Calamary, to be met with on our southern coasts at low tide. Its 'bone' is shaped somewhat like a spear or pen, and is often called the Sea Pen.

Marine Crustaceans

After taking another short peep at the sketches illustrating the structure of the Crayfish (p. 14), to refresh our memories concerning the general characteristics of the Crustaceans, we will briefly examine the common marine members of this group.

But although we may well look upon the Crayfish as a type of the crustaceans, yet we must remember that some of these creatures are so unlike the Crayfish in external appearance, that their position in the animal creation has been determined only after a careful examination. Take, for example, the little conical shells that almost completely cover some of our rocks between the tide marks: who would suppose them to be near relatives of our Crayfishes, Lobsters, and Crabs? Yet such is the case, as a careful observation of their development and structure will show. The shells to which we refer are known commonly as the Acorn shells (*Balanus*), and protect little creatures that belong to the *Cirripedia*, or Curl-footed crustaceans.

Let us first examine the shell itself, and we see that it is composed of several plates united at their edges, forming a cone with an open top. Then, by removing one carefully from the rock, we find that the cone has a base of the same material. The upper edges of the plates are so sharp that they cut our hands as we climb the steep and rugged rocks, and the apex of the cone is closed by a lid (the *operculum*), that stretches across it obliquely. But how shall we make our acquaintance with the creature inside? This is easy enough. Simply place a piece of detached rock, with a few of the shells on it, in a rock pool and watch. You will not have to wait long before six pairs of beautifully curled and jointed 'legs' make their appearance through a slit in each operculum. At once the Balani commence to capture their minute prey. The twelve legs form an admirable sweep net, which is alternately cast out and drawn in, thus bringing the small animals on which these creatures feed into their mouths.

FIG. 309.—BALANUS.

Perhaps, however, some of my readers are in London or some other inland place at the time of reading these pages. Must they, then, wait perhaps for months before an opportunity comes of witnessing the interesting movements of the Balanus? Not at all. Go to the nearest fishmonger's stall, and select an oyster, scallop, mussel, or other 'shell-fish,' with a few acorn shells on its valves. Then, all you have to do is to place your specimen in a tumbler of artificial salt water—one ounce of sea salt to a pint and a half of water—and watch it in a strong light. Many other interesting creatures may be obtained and studied in the same way by those who have no immediate opportunity of visiting the seaside; the crannies of some of the irregular oyster shells being especially productive, sometimes harbouring four or five species of living animals at the same time, without reckoning the very minute forms.

The Balanus, like all other crustaceans, undergoes metamor-

phoses; and the larva, as the earlier stage is called, is very unlike the adult.

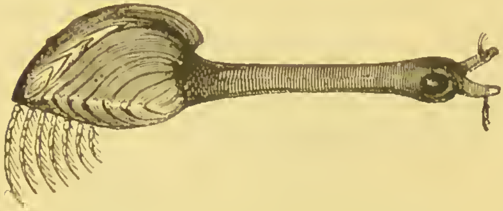

Fig. 310.—The Barnacle.

Fig. 311.—The Sand Hopper.

The Barnacle is another common member of the *Cirripedia*, but it is not met with very often on our shores. Its home is generally the under side of floating timber or ships.

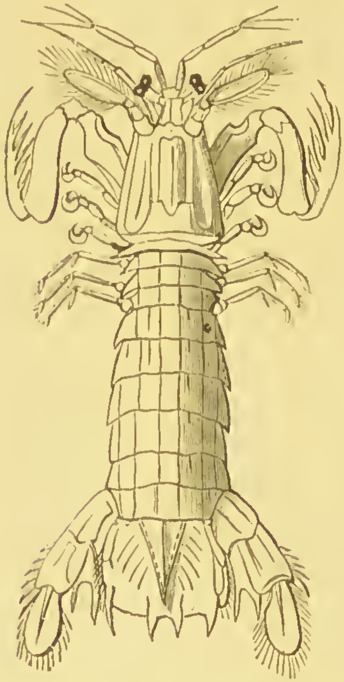

Fig. 312.—The Mantis Shrimp (*Squilla mantis*).

Our next crustacean belongs to the same group as the Fresh-water Shrimp and the Woodlouse. It is the Sand Hopper. Turn over the weeds and miscellaneous matter at high-water mark on a sandy beach, and hundreds of these little creatures will be seen jumping about furiously in search of another hiding-place. Let us catch one and examine it with a lens. Its eyes are not mounted on stalks like those of lobsters and crabs; and we observe a peculiar arrangement of the legs, the three hind pairs having joints that bend forward, and the front legs having joints that bend backward. It breathes by gills, but these organs cannot perform their duty unless moist, and hence we find the Hopper burrowing into moist sand, or pushing its way under damp weeds, but it never enters the water. It feeds on decaying substances, and may be looked upon as the chief scavenger of the sea-shore.

We must now briefly examine two creatures that represent the

Stomapoda (mouth-footed) the lowest division of 'Stalk-eyed' crustaceans. These are the Mantis Shrimp and the Chamæleon or Opossum Shrimp. Neither of these is very common on our shores, but the former has been frequently taken on the Cornish coast, and the latter has been seen in swarms in the waters off Weymouth.

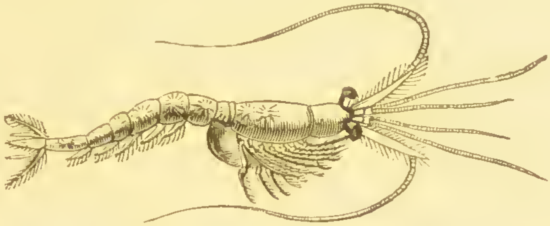

FIG. 313.—THE OPOSSUM SHRIMP (*Mysis chamælcon*).

When we come to the common Brown Shrimp and the Prawn we observe a wonderfully close resemblance to the Lobsters and Crayfishes—so close, indeed, that a general description of any one of them serves almost equally well for all the others. The Prawn, so abundant on the south coast, is caught in large numbers while young, and sold as shrimps; the older ones are often considered

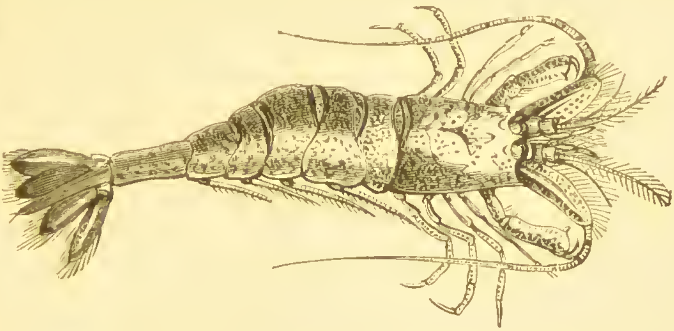

FIG. 314.—THE COMMON SHRIMP (*Crangon vulgaris*).

as belonging to quite a distinct species. It may be observed that the Prawn is armed in front with a toothed beak—a feature not possessed by the Shrimp: also that the Shrimp does not turn red when boiled. Both Shrimps and Prawns feed on carrion, thus performing the scavenger's duty in the water as does the Sand Hopper on the shore.

Shrimps, Prawns, Lobsters, and Crabs all possess five pairs of walking feet, including the pair of large claws, and hence we often find them grouped together under the head *Decapoda*, which signifies 'Ten-footed.' They all cast their skins at certain intervals, always remaining in a hiding-place until the new coat is sufficiently hard to protect them from their enemies. Lobsters are very quarrelsome creatures, and a combat between two of them is almost sure to result in the loss of one or more limbs. If a limb is seized by an antagonist, the captive immediately snaps it off at one of the joints above, and thus escapes apparently unconcerned at the loss, which, after all, is not of very great moment, for in course of time a new limb develops on the unsightly stump.

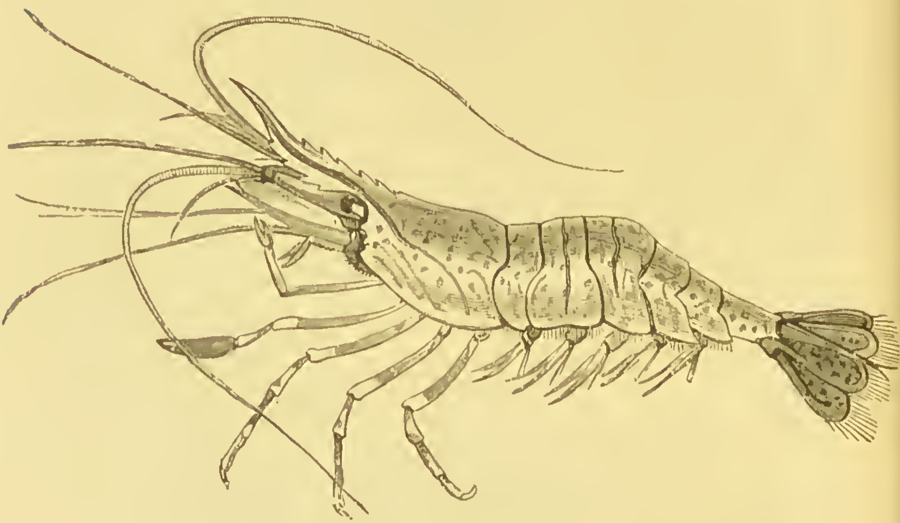

FIG. 315.—THE PRAWN (*Palæmon serratus*).

Although the bodies of Crabs (*Brachyura*) are very different in form from those of Lobsters, yet we find a great similarity in the arrangement of the parts. The most striking difference is to be found in the case of the 'tail.' We notice that Lobsters always show a tendency to turn their abdomens downward, and that they take powerful leaps backward by a sudden bending of the tail under the body. But in Crabs this portion of the body is permanently bent underneath, and closely applied to the under surface.

The common Shore Crab is another of the scavengers of shallow waters, and often spends much of its time out of the sea, hiding under stones and weeds between the tide marks. Its hind legs

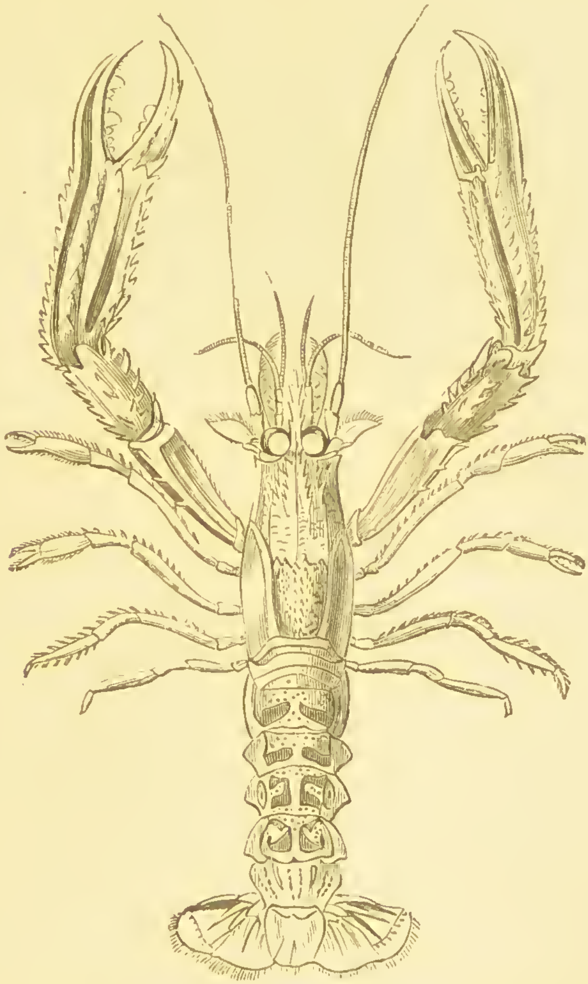

FIG. 316.—THE NORWAY LOBSTER (*Nephrops Norvegicus*)

are flattened and fringed with hairs, thus forming the chief swimming organs. This Crab is very hardy, and is easily kept alive in the aquarium.

The edible Crab may also be found under stones and in the

crevices of rocks at low tide, but the finest specimens generally inhabit deep water, and must be caught in some kind of trap. The usual snare consists of a wicker basket known as the 'CrabPot,' with

Fig. 317.—The Common Shore Crab (*Carcinus Mænas*).

an aperture at the top, and so constructed that the Crabs, once in, cannot find their way out again. These 'pots' are baited with fish, and let down by a rope with a cork float at the upper end to mark

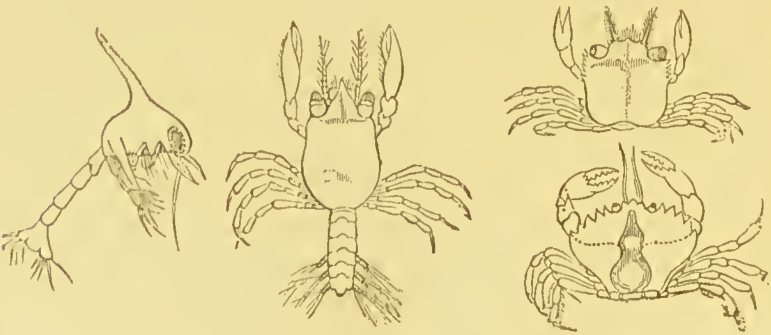

Fig. 318.—Early Stages of the Shore Crab.

its whereabouts. The same kind of trap is also used for catching Lobsters.

The Violet Fiddler or Lady Crab is very similar to the two species

just named, but may be easily distinguished by the blue ridges on its legs. I have seen hundreds of these under stones on the Cornish coast, where they seem to be especially abundant.

One of the most interesting of British Crabs is the Hermit or Soldier, called by the former name from its habit of living a solitary life, and 'Soldier' from its bloodthirsty propensities. Often, while looking into a rock pool, we observe a univalve shell making headway with unusual speed. The peculiar movements of the shell attract our attention, and out of curiosity we touch it, when suddenly it stops, and the active lodger shrinks well into its home. On picking it up and examining it, we find that it contains a strange-looking Crab, which has taken possession of an empty shell for its home. This creature will live well in the aquarium,

Fig. 319.—The Hermit Crab in the Shell of a Whelk.

Fig. 320.—The Hermit Crab (*Pagurus Bernhardus*) out of its Shell.

so we take it home and observe its habits, and we shall soon learn why this Crab, unlike its cousins, selects such a strange dwelling. At first it is very timid, and shrinks into its cell at the least disturbance; but soon it becomes accustomed to its new

FIG. 321. THE PEA CRAB (*Pinnotheres pisum*).

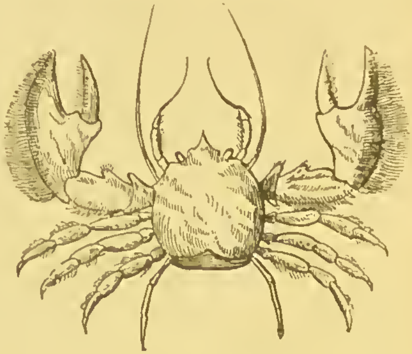

FIG. 322.—*Porcellana platycheles.*

quarters, and walks about, drawing its shell after it, just like a snail.

As it creeps along its body is to a great extent withdrawn from

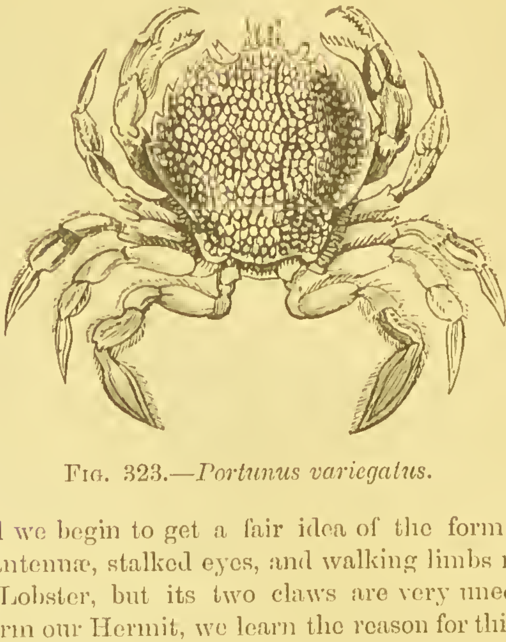

FIG. 323.—*Portunus variegatus.*

the shell, and we begin to get a fair idea of the form of our new friend. Its antennæ, stalked eyes, and walking limbs remind us at once of the Lobster, but its two claws are very unequal in size. When we alarm our Hermit, we learn the reason for this last-named

peculiarity; for the smaller claw is then entirely hidden, while the larger one serves to completely shut the cavity of the shell.

FIG. 324.—HENSLOW'S SWIMMING CRAB (*Polybius Henslowii*).

FIG. 325.—THE LONG-ARMED CRAB (*Corystes*), FEMALE. (THE CLAWS OF THE MALE ARE TWICE AS LONG AS THOSE OF THE FEMALE.)

There is one great difference between the Hermit Crab and the mollusc that originally inhabited its cell. While the mollusc lived, its shell increased in size, keeping pace with the development of its soft body; in fact, we may say that the shell was the mollusc's skin. But on the death of this creature the shell increased no more. So our growing Hermit inhabits a cell that will one day be too small to accommodate it. Knowing this, we drop some empty shells into our aquarium, and look forward to the day on which the change of houses is to take place.

Fig. 326. The Spider Crab (*Maia squinado*).

At last the time arrives. The Hermit is uneasy, and takes a tour round, examining the empty shells. Now it sees one that seems to suit its requirements; so it cautiously withdraws its body, and quickly thrusts it into a new shell. But this one is not exactly the thing, and it returns to the old home to have another search. Another trial, and it is suited, and takes over the premises on a short lease. It is only on such occasions as these that the Hermit exposes the hinder portion of its body, and by so doing explains the reason for its strange mode of living. The posterior part is not

protected by a hardened skin like the rest of the body, but is soft and limbless, and is provided with a kind of sucker by which it can attach itself to its temporary dwelling. Sometimes a Hermit will kill a mollusc in order to obtain a shell on which it has cast a longing eye; and it is probable that the numerous quarrels and fights among the Hermits themselves are to an extent caused by attempts to take possession of a coveted shell.

A few other British Crabs are figured, but we cannot find room for descriptions. Among them is the little Pea Crab that lives *inside* the shells of living mussels and other bivalves.

Fishing in the Rock Pools

While engaged in collecting marine objects, whatever be the nature of the specimens we seek, we are sure to meet with several species of fishes, mostly small, but none the less interesting on that account. If we approach a rock pool for the purpose of obtaining anemones, molluscs, sea-weeds, or what not, usually the first living object that attracts our attention is a little fish that makes a sudden dart towards a tuft of weeds, or to a secluded crevice in the rock. We should like to capture that little creature, and set to work with that end in view, but are surprised at the clever way in which it eludes our attempts. It darts from one tuft to another, and finally squeezes its body into a deep and small niche, where it remains perfectly safe until all danger is over.

If, however, we are to be successful in this matter, we must be specially provided with a small and fine net—something like our crab net, but very pointed. This must be dipped to the bottom, and swept *upward* among the tufts of weeds and in all the small angles of the pond.

Again, as we turn over the stones at low-water mark, we see other fishes at rest, awaiting the next return of the tide. These are often quite out of water, for they are species that are capable of living for hours in damp holes.

The little fishes caught in pools or under stones may be taken home alive in wet weed, and require no water unless the distance is considerable. They may then be kept alive for some time in any kind of vessel in which is a fresh supply of sea water; but they should also be supplied with some tufts of weed and corallines, and also some loosely piled stones from the shore to serve as hiding-places.

A large number of fishes live in the open waters, and very seldom approach *close* to our rocks; but some are of an opposite nature, haunting the recesses between the rugged rocks, and hiding in watch for their prey between the gently waving tufts of weeds. Many of the latter are known collectively as 'Rock Fishes,' and interesting creatures some of them are. As a rule they are not fit for food; but what is that to a naturalist, whose sole reason for hunting is to know the structure and habits of his captures? Post yourself on the summit of a rock and drop your rod-line into a deep and shady recess between two perpendicular, rugged, and weed-clothed masses, and you will soon secure some curious specimens. This kind of fishing is as interesting as any I know, and certainly is not a great tax on the patience of the fisherman; for, unless the position is not well chosen, the demand for bait is continuous. There is no particular art in this kind of fishing, for the rock frequenters are generally very greedy fish, and will bite at almost anything. Mussels and other molluscs are always acceptable. Marine worms are undoubtedly a luxury. But, failing these, many will make a dash at a piece of red worsted, or a small strip of red flannel, especially if it is kept moving.

Take with you a good supply of hooks, for you are sure to lose a number before you become acquainted with the nature of the nooks in the rock and the peculiar habits of the rock dwellers. Take the 'Father Lasher' for example. As soon as it bites, it darts back into its hiding-place between the rocks, and there holds on by its spines so firmly that to pull it out is almost impossible. Some of the 'Rock Fishes' are very hardy, and certainly very powerful for their size. They also seem to be almost insensible to pain. On one occasion, having fished for only about twenty minutes on a rocky promontory of the Cornish coast, and having lost in that short time about five or six hooks, I hauled up a 'Bullhead' about five inches long, and, to my surprise, found that I had already caught it twice before, for the three strands of gut projecting from its mouth showed that it had previously broken two hooks from my line.

We cannot now go into the details of deep-sea fishing, whiffing, trawling, &c.; for our object is to deal with the coast only. But, if ever you have the opportunity of gaining the companionship of a good-natured fisherman, by all means embrace the opportunity of getting an insight into his art. You will then get something better than book knowledge concerning the fisherman's work; but be careful that you receive his natural history 'facts' with great caution.

Preserving Fishes

The simplest method of preserving small fishes is to put them into well-corked bottles, or, if your means permit, into stoppered specimen jars containing spirit. It is not necessary that the spirit used be pure, for if diluted with its own volume of water it answers quite as well.

In many cases you will observe that the layer of slimy substance covering the skin of a fish becomes white and opaque in spirit, and that it often peels off, imparting to the liquid a very muddy appearance; in fact, quite spoiling the look of the specimen. Hence I recommend the following method of dealing with them: Keep a large jar of diluted spirit for all the fresh specimens. Put them into this, and keep them there for a week or so. Then take them out, remove all the whitish substance from their skins by means of a brush, and, when quite clean, transfer them to the smaller bottles or jars in which they are to remain permanently, with a fresh supply of spirit.

The preparation of the skeleton of a fish requires much care, especially if the fin rays are to be preserved as well as the skeleton proper. The skin must first be very carefully removed without touching any of the harder supporting structures. Then open the body cavity along the under surface, and remove the internal organs. Next, by means of a sharp knife, remove the flesh as much as you can, again being very careful not to disturb the harder structures. When this dissection has been carried as far as possible, place the remains in a shallow dish with sufficient water to cover it. The remainder of the soft parts will gradually break up with this soaking, and with frequent changes of water, and the occasional use of a soft brush, you will, in a few days, be rewarded with a splendid specimen of the framework of the fish. It must now be removed from the water, and suspended on wires to dry; and any part that has become detached may be fixed in its proper place, when dry, with a little coaguline or by means of fine wires.

Some common Fishes of our Coasts

Perhaps the commonest of all our shore fishes are the Blennies, of which we have several species. We meet with them in almost every rock pool, and often find them under stones. Even a little pool, containing only a gallon or so of water, is almost sure to contain a Blenny. The commonest species is the Smooth Blenny or

Shanny, of which we give an illustration. It is a heavy fish, it has no swimming bladder, and consequently spends its time either on the bed of the pool, or resting on the weedy tufts. It is a peculiar fish. The eyeballs can be moved independently of each other, one being turned upward, if necessary, on the look-out for formidable biped monsters, while the other is cast in another direction in search of food. It will live for some time in *fresh* water, and may be frequently found in holes far above the water's level. It has even been caught basking in the hot sunshine on ledges of rock, but always with a safe retreat in the rear; and when alarmed it darts backward into its little niche with the aid of its spiny fins. I have often kept Blennies alive for several days in moist weed, and then transported them by rail for a distance of over two hundred miles, apparently without causing them any inconvenience.

There are not many small fishes that will attempt to bite their

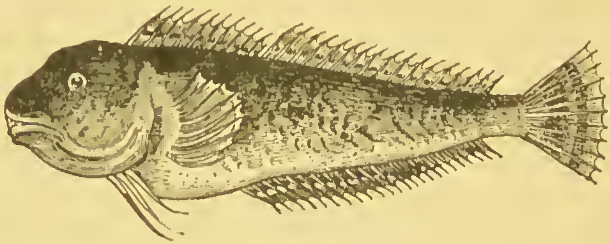

Fig. 327.—The Smooth Blenny.

captors; but try the Blenny—one of about four or five inches long. It will hold on to the tip of your finger with such power that it is not easily shaken off, and its well-developed front teeth will often make your blood flow. These teeth, by the way, are used by the Blenny in removing Limpets and other molluscs from the rock.

All the Blennies have short snouts, in which respect they resemble the Cat or Wolf Fish. This latter is a very ferocious inhabitant of our seas, armed with powerful teeth and cat-like eyes, and always ready to fight desperately when caught.

The Cornish Sucker is another curiosity of animal life. It is provided with sucking discs by which it attaches itself to rocks and weeds. If you wish to see how it uses this apparatus you have simply to take one in your hand. It will shake its body, probably to adjust its sucker against the skin, and then you find it so firmly fixed that you can invert your hand without its falling off. This

fish is found on most parts of our rocky shores, but derives its name from the fact that it was first found on the Cornish coast.

Fig. 328.—The Cornish Sucker.

You will probably remember what has been said concerning the lively 'Tittler' of our fresh-water ponds, and of its nest-building and other domesticated habits. Well, we have another such fish frequenting our shores, a cousin of the 'Tittler,' known as the Fifteen-spined Stickleback or Sea Adder. It is not very well known to young collectors, for it generally inhabits the rock holes beyond low-water mark; but is sometimes found in pools between the tide marks. Its nest is made of weeds, bound together by a silky fibre, and the eggs are mixed up in tho meshes, being laid at intervals during the building of the nest. Both eggs and young are guarded vigorously by the parents.

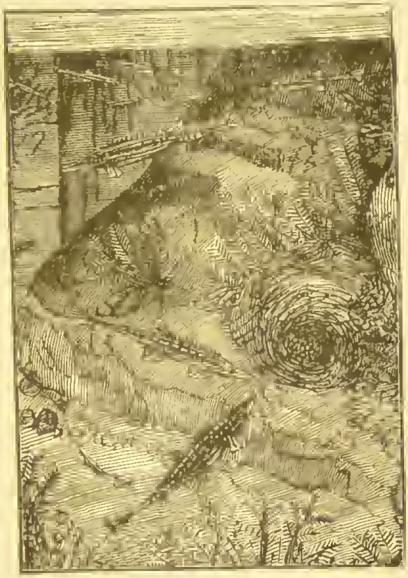

Fig. 329.—The Fifteen-spined Stickleback and Nest.

I take this opportunity of recommending all those of my readers who are desirous of becoming acquainted with the natural history of our British fishes, to read the admirable work on this subject by Couch, whose close observations and pleasant writings have added much to our knowledge and increased our interest in this branch of natural science.

The Father Lasher, known also as the Sea Scorpion and the Lucky Proach, is a marine Bullhead, allied to the Miller's Thumb of our fresh-water streams. It is very prettily marked with black and

grey mottlings, the colour of the male being especially rich ; still it is often looked upon as an ugly creature ; and the big head and formidable spines have certainly a questionable aspect. This fish is very common in rock pools, but the finest specimens are to be caught

FIG. 330.—THE FATHER LASHER.

with a rod and line off the rocks at low tide. As soon as it is pulled out of the water it raises its spines and spreads out its gill covers in preparation for the attack ; and, unless handled very cautiously, it will thrust its spines well into your flesh.

FIG. 331.—THE GOBY.

All the rock fishes just mentioned belong to the spiny-rayed order, as may be judged from the figures shown. To them we may add the Gobies, which much resemble the Blenny in habits ; and also

FIG. 332.—THE LESSER WEEVER.

the Weever Fish that burrows into the sand, and there rests with only its mouth exposed.

Among the soft-rayed fishes we may mention the Bearded Rocklings, two species of which are common under stones at low tide,

and the well-known Sand Eel. Hundreds of the last-named fish may be seen at a time on sandy coasts, especially in the south-west.

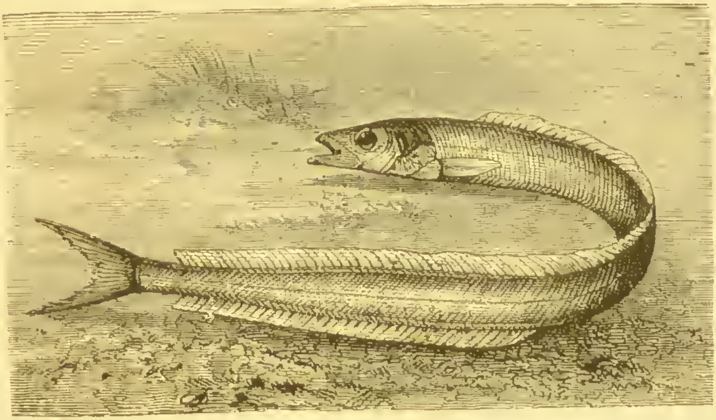

Fig. 333.—The Lesser Sand Eel.

They burrow into the soft and moist sand; and, as the tide recedes, they may be seen as far as the eye is capable of detecting them, popping up their heads, and wriggling their bodies till free from the sand. Thousands are killed by the heat of the sun, being unable to return into the sand after it becomes dry and hard. They are largely used by fishermen as bait. Their eggs are laid in the burrows.

Fig. 334.—Egg Case of Dog Fish.

Amongst the varied collection of substances thrown up by the breakers we often see strong black leathery cases, oblong in form, with spines or tendrils at the four corners. These are commonly known as Mermaid's Purses and Skate Barrows. They are the egg cases of the Skate and of the Dog Fish. The latter have twining tendrils, which are of service for mooring them to weeds, thus assisting in keeping them in safety till the young have escaped.

CHAPTER IV

SNAILS AND SLUGS

Snails and Slugs are land molluscs. You will find them very interesting creatures if you will only overcome the common prejudice against them on account of their slimy skins, and you may form a very pretty and useful collection of their shells.

They all belong to the head-bearing molluscs, and breathe by means of a lung that communicates directly with the outer air. In the Common Snail (*Helix aspersa*), and in most of the others, the

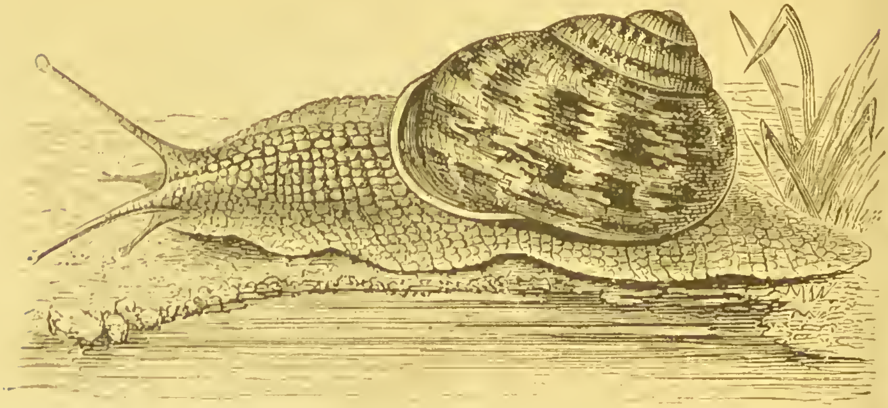

Fig. 335.—*Helix aspersa.*

breathing aperture may be seen on the right side when the animal is fully extended. At such times the 'collar' is exposed round the rim of the shell, and it is here that the aperture is to be seen.

The slimy character of the skin is caused by a thick mucus which the creature is continuously secreting. This secretion is absolutely necessary to the animal, for it cannot live with a dry skin.

Snails hibernate during the winter; and if you examine one at this season you will observe that the mucus has hardened over the

Plate VIII

mouth of the shell, thus forming a protective covering that answers the same purpose as the *operculum* in the Periwinkle and Whelk. But although the Snail can pass the winter without food, it does not seem to be able to exist without air, for you will always see a hole in the dried secretion.

Some of the Slugs make a rather curious use of this same substance. When one of these creatures wishes to descend from a tree which it has been exploring during the night, it allows itself to descend to the ground on the end of a thread of mucus, which hardens on exposure to air.

Slugs are often regarded as molluscs without shells, but a closer

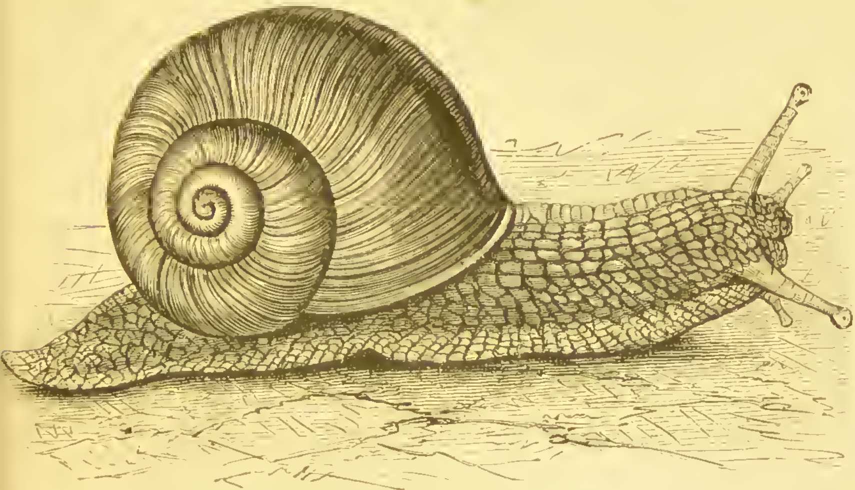

FIG. 336.—*Helix pomatia.*

examination will prove that such is not the case. It is not always, however, that the shell is external. The so-called Snail-slug (*Testacella*) has a small shell on the tail; but the majority of the Slugs have either a shield-like shell underneath the mantle, as the thick skin is called, or else a number of little grains of calcareous substance loosely arranged in a similar position.

The arrangement and mechanism of the eyes and tentacles form another interesting feature of the land molluscs, and it will repay anyone to watch them closely as they glide about so gracefully with these organs extended. Some have four horns, with the eyes situated at the extremities of the upper pair. Others have their eyes at the bases of these horns.

The horns of Snails and Slugs are retractile, and are drawn in partially or completely whenever they touch any substance that obstructs their path. If you gently touch one of the mounted eyes of either of these creatures, that eye immediately disappears inside the tentacle in a marvellous manner. The motion is a very peculiar one, and not easily understood without a close examination. But with care you may see that the tentacle is pulled inside out, or, more correctly, outside in. A muscle passes from the tip of each tentacle into the head; and when this contracts the effect is exactly similar to that produced by pulling a string fixed inside to the tip of a finger of a glove.

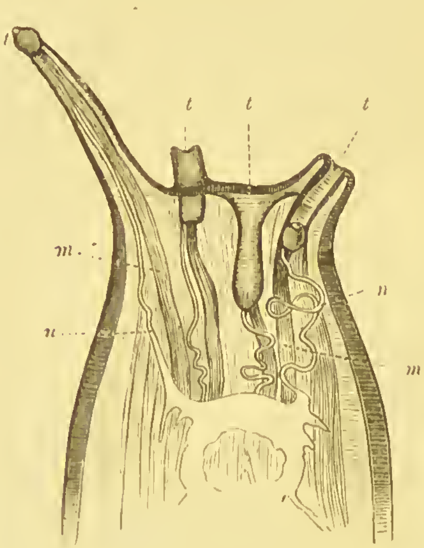

Fig. 337.—Diagram of the Head of a Snail.

n, nerves; *m*, muscles; *t*, tentacles.

Let us now see what can be done in the way of collecting and preserving these soft-bodied animals.

They are extremely variable in the selection of their resting places and feeding grounds—so much so that it is difficult to say where they are *not* to be found. Some species are particularly partial to old walls, especially if there is vegetation in the crevices or at the base to supply them with food. Overturned stones will generally reveal a rich harvest of both Snails and Slugs; and the moss growing at the roots of trees should always be examined by the collector. Nettle beds in damp and shady places are extremely productive, and if you will only examine the stems and under surfaces of the leaves of the nettles you are sure to be rewarded with a variety of species; but if you start out with the intention of searching these plants, be sure that you take your gloves. During the autumn you may find plenty among the fallen leaves, especially in damp localities; and at all

Fig. 338.—*Succinea putris*.

seasons the herbage that covers the banks of ditches and streams should be examined.

Put your specimens in chip boxes, preferably with a leaf or a few blades of grass; and make any notes you desire either on the box itself or in your note book.

Now we have to deal with the methods of preserving both the shells and the soft parts of the land molluscs.

If you desire to preserve the shells only, your process is simple enough. You have merely to kill the animals by plunging them into boiling water, and then remove the bodies of Snails with a bent wire, and extract the shells of Slugs with a sharp penknife, or your scalpel if you have one. The shells must now be washed and dried, after which the smallest of the Snail-shells and those obtained from the Slugs may be mounted on small cards.

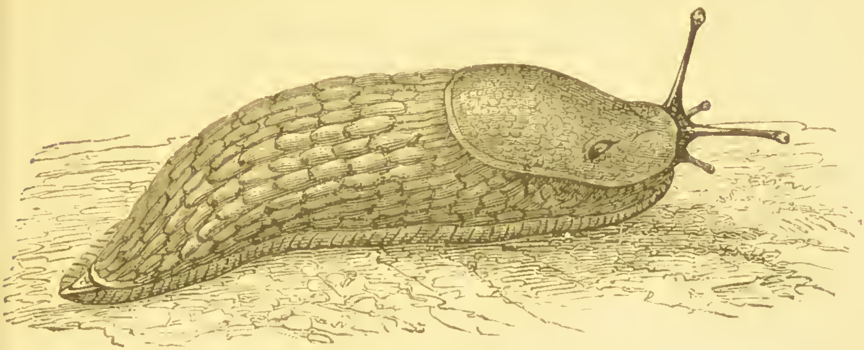

Fig. 339. *Arion ater.*

Some collectors recommend the thorough cleaning of all shells (and especially those of aquatic molluscs) with a tooth brush. But this, I think, is not a good plan, for it may injure the delicate surfaces of many of the specimens; and, in the case of Water-snails, the growths that cover the shells are often in themselves very interesting objects of study, besides being a normal feature of the aquatic molluscs. Where, however, you have a number of shells of the same species, one at least might be quite cleared of vegetable growth.

Slugs may be killed by dropping them into spirit or turpentine, but both of these have the disadvantage of causing the creatures to die in a more or less contracted state. They should be preserved with their bodies and their tentacles fully extended, and this may be accomplished very successfully by means of corrosive sublimate.

Put a saturated solution of this poisonous substance into a wide-mouthed bottle. Next, place your Slug on a narrow slip of glass, and wait till it commences to crawl with tentacles well extended. Now plunge glass and Slug together into the solution, and the creature will die almost immediately without changing its form. Snails may be treated in the same way if you desire to preserve them in liquid.

Before finally storing the molluscs in your specimen tubes or bottles, the slimy mucus that covers their skins must be entirely cleaned off.

There are several preservative fluids suitable for these creatures. but, perhaps, few are simpler and more perfectly adapted to the purpose than turpentine, or a mixture of equal parts of water and glycerine. A mixture of spirit and glycerine is also good.

FIG. 340.—*Testacella.*

Slugs may also be preserved in a dry state; or, rather, their skins may. The process is as follows: Make an incision in the skin on the under side, and extract all the internal organs. Then dry the skin as far as you can by pressing it between sheets of blotting-paper; and, after dusting the inside with a very little finely powdered alum or corrosive sublimate, stuff it with cotton-wool, work it into its natural form as perfectly as you can, and set it aside to dry. When dry, you can restore the natural gloss to the skin by means of a little varnish.

The skins of Slugs may also be preserved in the same way as recommended for Larvæ on p. 131.

The woodcuts interspersed with this short chapter, together with a few coloured illustrations on Plate VIII, will assist the young collector in identifying some of the common species.

CHAPTER V

SPIDERS, CENTIPEDES, AND MILLEPEDES

It is impossible for a naturalist to proceed with any kind of field work without being continually brought into contact with the creatures whose names appear at the head of this chapter. Wending his way through lanes or woods, the delicate silken threads of Spiders, floating in the breeze, though generally so fine as to escape observation, incessantly make themselves known by a gentle irritation of the skin. Large and conspicuous snares constructed by other kinds are seen among the bushes at almost every step. When beating the herbage for larvæ, he will generally find a number of Spiders among the dislodged occupants. His sweep net, though aimed at larvæ or beetles, will almost *always* contain a fair sprinkling of these eight-legged intruders; and, whether searching tree trunks, digging for pupæ, or overturning stones for any form of living creature, he is sure to surprise a host of Spiders, Centipedes, and Millepedes, some of which will scamper away as fast as they can into the nearest dark corner, while others will feign death to avoid, if possible, being observed by the monster who so suddenly brings them to light.

A good many collectors devote nearly all their attention to certain classes of living beings, almost entirely neglecting those forms which they have not yet learnt to love. Thus, many an entomologist knows but little of Spiders and the many-legged crawlers; and, although so familiar with their general appearance, always regards them as the useless refuse of animal life, and throws them on one side without even a thought. But why should not these creatures have a claim to be ranked among the objects of our study? Is it because they are not beautiful, or that their habits exhibit no interesting features? Most certainly neither of these descriptions could be truthfully applied to any of the creatures we are now speaking about; and, if the naturalist finds no particular

desire to become acquainted with them, it is simply because he does not yet *know* sufficient of them to cause his interest to be aroused.

Perhaps the following brief remarks may lead some to take a little interest in the study of their structure and habits.

Spiders

Spiders are so widely distributed that it may be truthfully said they are to be found everywhere except in the ocean. Consequently, should you like to try your hand at Spider hunting, you will have no need of even a moment's consideration as to the most likely localities; you will meet with them in the most unpromising spots.

The paraphernalia, too, of the collector of Spiders is of the most simple description. All you need is a number of pill boxes and a sweep net.

As you walk through a field you can obtain a good many species by sweeping your net amongst the tall grasses, and the same remark applies to the herbage of hedges and banks. But this method, although it fills the boxes most satisfactorily, is open to one grave objection, for it does not enable you to become acquainted with the habits of the species you collect. One of the most interesting features of certain Spiders is the wonderful skill and instinct displayed in the construction of their snares; but if your specimens are captured by sweeping or beating the herbage, you entirely lose the opportunity of noting this.

How, then, shall we set to work? Search carefully among the herbage, in all kinds of chinks and crannies, and under stones. Each time you meet with a Spider, and especially if it be a species with which you are not already familiar, carefully observe its web, if any, and its habits as far as you are able. After you have thus satisfied yourself, cautiously box your specimen, and write down all the facts concerning your captive that you consider to be worth remembering. Such notes may be written on the cover of the pill box; or you may simply place a number on the box itself, and write the notes opposite a corresponding number in your pocket-book. The webs of Spiders should always be accurately described; and you should never omit the nature of its haunt—whether among bushes or grass, on the bark of a tree, or in a hole of a wall, and whether in a damp or in a dry situation.

You will observe a great difference in the behaviour of the

various species when alarmed. Some will make off as fast as their eight long legs can carry them, while others will immediately drop from their position, leaving a fine silken cord for the return journey (should they be fortunate enough to require it), and feign death with folded limbs till all danger is apparently over.

The latter are easily secured as a rule, for they may be made to drop directly into the pill box held beneath them when they are disturbed; but on the ground these mimickers are best manipulated with a small pair of forceps. But why use forceps? Is it because Spiders bite? Well, many kinds certainly do so, and pretty powerfully too in proportion to their size; but none of the British species are to be feared on that score. The forceps are recommended for these as for all small and delicate creatures, because with this instrument they are less liable to injury than when held between the finger and thumb.

The next question is—What shall we do with our specimens when we reach home? To this my first advice is: Deal with each one separately, so that its identity be not lost, and the notes taken be thus rendered useless. There will be no need to hurry on with the preserving and labelling, for Spiders will not harm with a few hours' confinement in a pill box. Proceed with each one as follows:

Tip it out into a wide-mouthed bottle containing either turpentine or *undiluted* spirit. As soon as it is dead, transfer it to a small specimen tube of turpentine, cork it securely, and label it at once, with its name if you know it, but if not, with the number against the notes taken at the time of its capture.

The specimen tubes may be obtained at the dealers' for a few shillings a gross; but if the collector has had a little experience in the manipulating of glass tubing, he will be able to make them for himself at less than half the cost.

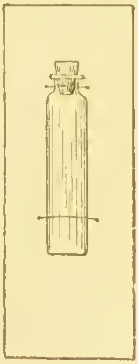

Fig. 341.

When your tubes are ready, they may be stored in any kind of shallow box or drawer. They may be laid in compartments of suitable size, and so prevented from knocking against each other when moved about; but another plan is to fasten each bottle to a separate piece of card by means of two bands of cotton, as shown in fig. 341. I think the latter method is far superior to the other, for the writing can be placed on the card instead of on a

label, thus placing no obstacle in the way of future observations; and if all the cards be of the same size, they will lie neatly in the box or drawer without much fear of displacement.

I will now give a short account of a few of our Spiders, and then conclude with a table of classification that will be found useful to young collectors who wish to take up this branch of natural history.

For our first example we will take the well-known Garden Spider, of the family *Epeiridæ*, whose beautiful webs are to be seen in almost every square yard of our gardens in the summer. This creature is too familiar to need a description, but its wonderful architectural powers must not pass unnoticed.

Fig. 342. The Garden Spider.

Here is a Garden Spider, apparently seeking a suitable spot in which to construct its web. Let us watch its movements closely. First it applies its spinnerets to a stem, and then walks away, leaving a fine thread behind it. A few paces off the tightened fibre is fastened to another object, and then another line is formed. In this manner the creature continues to work, apparently in a very irregular and aimless fashion, till it has stretched a number of threads from one projecting object to another, covering a wide area, but leaving a central space quite devoid of threads.

These outer lines, though necessarily irregular on account of the relative positions of the points connected, are the foundation of the very regular and beautiful structure that is to fill up the blank within. The Spider then decides on its central point, and spins a number of strong radiating lines, all of which are double threads, from this point to the various parts of the foundation. Now the whole has something the appearance of the spokes of a very delicate wheel. The Spider next takes up a position in the centre again, and, applying its spinnerets to one of the radiating threads close to the point at which they meet, starts the construction of the spiral. It passes the tip of its abdomen quickly from thread to thread, at each movement laying a very elastic line, and gradually increasing the diameter of its spiral till satisfied with the dimensions of the snare.

The building of the whole of this structure occupies less than an hour; and, the work being over, the Spider retires to a neighbouring nook, where it can watch for its prey, and where, by means of a communicating thread, it can feel the vibrations of the web.

If now we take a lens and examine the structure carefully, we observe that the threads of the spiral differ remarkably from the others. They are exceedingly fine, and, except those near the centre, are studded with little globules of a sticky substance. These, then, are the threads that hold fast the unwary flies, while the thicker radiating lines are merely a supporting framework.

The spiral thread, too, is constantly renewed, so that a fresh supply of the gummy substance is continually replacing that which has lost its holding power through exposure to the air.

Our voracious Spider is now in its parlour, watching with sharpened appetite the expected approach of a poor innocent fly. At last a sturdy bluebottle plunges into the almost invisible web. In a moment the Spider is on the spot; but the fly, after a brief and desperate struggle, narrowly escapes from its hungry foe, leaving the snare in a somewhat damaged condition.

The Spider does not find it necessary to repair the rent at once, but retires to its den with its appetite keener than ever.

Before long another poor victim becomes entangled in the fatal net, and the vicious monster pounces on its struggling prey, seizing it with its jointed 'jaws' (*falces*), and at once commences to turn it round and round with the help of these appendages and the third pair of legs, at the same time applying its spinnerets, and drawing out numerous fine threads with its hind limbs, till the poor fly, completely wrapped in a dense covering of silk, cannot move a single joint.

The bound captive is now mercilessly dragged into the awful dungeon, and is soon sucked dry, nothing being left but the limbs attached to an empty skin.

Thus the Spider enjoys the whole of the sunny summer; and, on the approach of colder days, when food is not forthcoming, prepares a silken cell in which to pass the winter months.

The female Spider lays a large number of eggs in October, all in one dense mass, and surrounds them with a cocoon of yellow silk. Throughout the winter plenty of these cocoons may be seen under the shelter of our garden walls and fences.

The webs of House Spiders, of which there are two species, form a kind of gauzy sheet, with a tubular portion in which the owner

conceals itself. All the threads are of the same kind—very fine, and not dotted with a gummy substance like the spiral of the Garden Spider. When a fly alights on such a web, it is held by the feet, which become entangled in the fine meshes; and a number of threads that run from the snare to the den form a means of communication by which the vibrations are conveyed to the Spider, so that even in its moments of lethargy it is aroused by its victim's struggles.

FIG. 343. *Segestria senoculata*—A SIX-EYED SPIDER.

FIG. 344.—CRAB SPIDER (*Thomisus lanio*).

FIG. 345.—THE STONE SPIDER (*Drassus lapidicola*).

The Crab Spider is so called from its singular habit of sometimes walking sideways like crabs. The peculiar arrangement of its legs, which are spread out widely, the first two pairs particularly being much longer than the others, is especially adapted for this habit. Like some of the crabs it also feigns death when alarmed, rolling up its legs, and allowing itself to be roughly used without showing the least signs of life.

FIG. 346.—A FEMALE WOLF SPIDER (*Dolomedes*) WITH EGG BAG, ENLARGED.

The Wolf Spiders form another group. They have received this name probably on account of their habit of prowling about in search of their prey; for they spin no kind of snare like many of their relatives. One of them is known as the Raft Spider. It is a large and really beautiful creature, of a rich chocolate colour, bordered by a broad orange band, and adorned with a double row of white spots. It loves damp places, and often takes to the water, when it either runs briskly on the

surface, or searches out its prey on some floating substance. It will even construct a raft by binding together fragments with its silken

FIG. 347.—THE RAFT SPIDER.

threads, and then allow itself to be carried away by wind or stream. If now it chances to see an aquatic insect on the water, it runs from its raft, seizes its prize, and then returns to the raft to enjoy its meal. It cannot dive like the Water Spider, but it often takes short excursions beneath the surface by creeping down the stems of aquatic plants. This creature shows a marked affection for its offspring. The cocoon, containing more than two hundred eggs, is carried about by the female till the young are hatched; and for a time she is very attentive to her numerous family.

FIG. 348.—*Salticus scenicus*, MAGNIFIED.

The Salticus is an active little fellow that may be seen almost everywhere, in town and country, creeping over walls and trees in the hot sunshine. If you disturb it, away it

starts with a series of short jumps; but if it considers itself to be in danger, it drops to the ground on a fine thread. When following up its prey its manner is exceedingly cat-like. It makes a very gradual approach towards the coveted fly, exhibiting a wonderful degree of caution and slyness till very near; and then, with a sudden spring, seizes the prize in its limbs and jaws. The white silken cocoons of this Spider, containing from a dozen to twenty eggs, may be seen in the crevices of walls and the bark of trees.

Classification of Spiders

Family 1. **Epeiridæ.** Webs with regular radiating and concentric lines. First and second pairs of legs longer than the others. Feet terminate in three or more claws. Eyes in two rows. Abdomen large, round or oval.

Family 2. **Theridiidæ.** Webs irregular. All legs long and slender; first and second pairs longest. Feet with three claws. Eyes in two rows. Abdomen large and angular.

Family 3. **Tegenariidæ** or **Tubitelæ.** Webs usually sheet-like, with a tubular den. Intermediate legs shorter than the others. Generally two claws on each foot. Eyes in two rows. Abdomen large and rounded. This family includes the common House Spider.

Family 4. **Thomisidæ.** Eyes in two curved rows. First and second pairs of legs longer and stouter. Two claws on each foot. Abdomen broad and flattened. This family includes the Crab Spiders.

Family 5. **Lycosidæ.** Eyes in three rows. No webs. Wanderers. Legs strong and hairy; first and second pairs longest. Three pairs of spinnerets. This family includes the Wolf Spiders.

Family 6. **Salticidæ.** Eyes in three rows. No webs. Wanderers. Legs short, stout, and hairy, terminating each in three claws. Abdomen egg-shaped. Three pairs of spinnerets.

Family 7. **Mygalidæ.** Eyes: four large and four small. Legs short and strong; first and fourth longest. Abdomen oval. Two pairs of spinnerets—one pair very small.

Centipedes and Millepedes

These creatures are known to almost every schoolboy as 'Hundred-legs' and 'Thousand-legs.' The names 'Centipedes' and 'Millepedes' have exactly the same meanings. They are simply the schoolboy's names dressed in the more fashionable Latin garb.

But it must not be assumed that the creatures in question possess the exact number of legs that these words express; for the actual numbers are far less in both cases.

I need give no directions for the collecting of Centipedes and Millepedes, for you are sure to meet with them wherever you go; and if you spend some little time in hunting for other and more attractive forms of life that inhabit the soil and sheltered nooks, you will probably meet with just as many of the 'many-legged' as if you searched especially for them. Still I may mention the fact that their favourite haunts correspond with those of most of the beetles. They are lovers of darkness, lurking during the daytime under stones and bark, and gnaw their way into rotten wood.

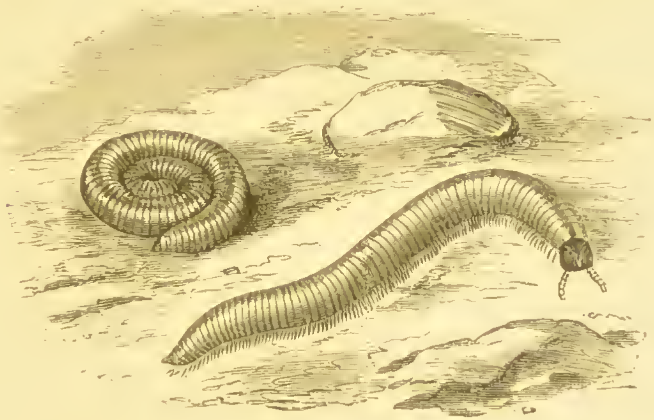

Fig. 349.—A Millepede (*Julus terrestris*).

They are best preserved in tubes of spirit or turpentine, as recommended in the case of Spiders.

If you examine any one of the animals of this group (*Myriopoda*) you will observe that the body consists of a number of distinct segments, all, or nearly all, of which bear a pair of short limbs—in some of the Millepedes we may count many more than a hundred. They all have distinct heads, with a pair of antennæ, and generally simple eyes arranged in groups.

In many respects they resemble insects. They breathe by tracheæ and are reproduced by eggs. At first the young have only three pairs of legs, and the eyes are few in number; but as they advance in life new segments are formed between the old ones, and the number of eyes gradually increases.

The Millepedes are also known as Galley Worms and Wire Worms. Their bodies are long and wire-like, not flattened like those of Centipedes, each segment being a complete ring, bearing a pair

Fig. 350. A Centipede.

of very short hair-like legs jointed close together on the under side. They feed on both animal and vegetable substances, and roll up into a coil when alarmed.

CHAPTER VI

REPTILES AND REPTILE HUNTING

What is a Reptile? Let us see what the dictionary has to say on the subject: Reptile, a creeping animal (L. *repo*, to creep). This definition is beautifully brief, but will it answer our purpose? I think not. Hundreds of the creeping creatures of this globe are quite distinct from the Reptile class, and a large number of the true Reptiles can scarcely be said to creep at all. Anyone who has seen the beautiful little Lizard of our heaths and banks darting about in the sunshine after its prey would at once discard the above definition. But, indeed, no definition that is sufficiently brief for insertion in an ordinary dictionary could possibly answer the question with which we started, for the answer must be framed in such a manner that it shall include *all* Reptiles, and, at the same time, exclude all those creatures that do not belong to the class.

I will not attempt to give an abbreviated technical definition, but will answer the question by giving some of the most striking features that form the distinguishing marks of the *Reptilia*, confining my remarks to Snakes and Lizards—the only divisions of the class represented in Britain.

We have already observed that the heart of a frog has only one ventricle, and that, as a result of the incomplete aëration of the blood, the temperature is low. The same is also true of Reptiles, hence we speak of them as cold-blooded animals. They do not undergo metamorphoses like frogs, toads, and newts; but the young are much like their parents, and they breathe by means of lungs throughout their term of life.

The skin of Reptiles is very characteristic. The under layer or *dermis* is drawn up into a number of regular folds, and the outer skin or *epidermis* is of a horny nature, very thin and almost trans-

parent, and, lying close on the folds of the dermis, looks as if it were composed of a number of distinct scales like those that cover the skins of fishes. This outer layer is shed at intervals, generally in one piece.

Some Reptiles are *oviparous*—that is, they lay eggs from which the young are afterwards hatched, just as is the case with birds and fishes. But others are said to be ovo-viviparous. These also lay eggs; but the eggs, instead of having a definite shape, consist of a very delicate soft skin, through which the young, well developed at the time of laying, can be seen wriggling about in a most active manner; before many seconds have passed, each has succeeded in bursting the thin membrane that inclosed it, and has started its new life, entirely or almost entirely independent of its parent.

British Lizards

Ask your schoolfellow if he has ever seen a Lizard, and he will reply, with a look of great surprise at your apparent ignorance, 'Why, yes, of course I have; *thousands* of them.' Now ask him if he can take you to a place where you are likely to catch some, and he will be almost certain to lead you to a pond swarming with *newts*. 'But,' you say, 'Lizards live on land, and seldom or never enter water.' Still your companion will pity your ignorance, and assure you that he has often seen the creatures now in the pond on dry land. In this last remark he would be correct, for newts spend only a portion of their lifetime in water; but it is evident that he does not know a Lizard.

If you want to catch Lizards, you must go to a dry heath, exposed to the full blaze of the summer's sun, with numerous tufts of coarse low herbage or clumps of furze to afford them shelter. Hedges and banks facing the south are also likely spots, providing they are not sheltered from the sun, and, as a rule, the drier the better, though I have at times seen large numbers on damp slopes close to a stream, and have even had to wade through the mire to catch them among the reeds and coarse grasses.

No ordinary box will do for imprisoning these active creatures, for it will often happen that, as soon as you raise the cover to put one in, two will pop out and jump into the thick herbage, where recapture is hopeless. Your box (and one is quite sufficient) should be of moderate size. The lid should be kept closed till your return, and all your captures introduced through a small hole in the top,

which may be closed by a cork. Make a number of small holes to admit air, and put a quantity of dry grass inside.

Lizard catching, or rather Lizard sighting, illustrates the value of eye-training as much as anything I know. On several occasions I have been on a hunting expedition with a small group of boys who had not done much field work; and, on reaching a suitable spot, have set them to search for four-legged Reptiles. Lizard after Lizard would they pass without ever seeing it—not that they did not know what a Lizard was like, but their eyes could not detect the form and varied colouring of the creatures amongst the equally varied tints of the herbage. Now and then one would suddenly shout, 'Here's one!' but he did not see it till it was in the act of

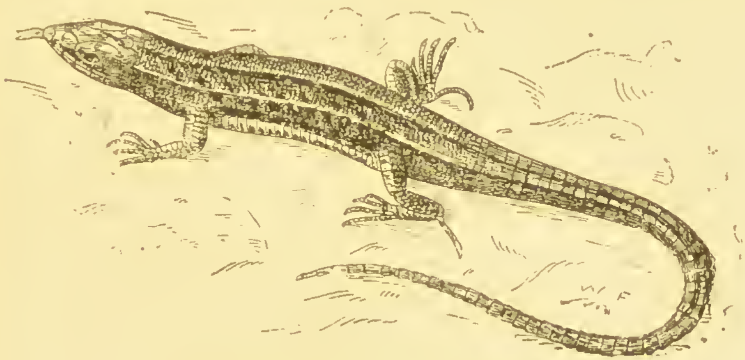

Fig. 351.—The Common Lizard.

darting away; and hardly were the words uttered before the Lizard had disappeared.

When searching a bank or heath you must walk slowly and very cautiously, so that the creatures may not be frightened away before you are near enough to grasp them. You may not go far before you espy the beautiful form of our Common Lizard (*Zootoca vivipara*), basking in the sun on a bare stone or a tuft of grass, with its body flattened out so as to expose a larger surface to the sun's rays. Here it rests quite motionless, except that the sides of its neck are alternately contracting and dilating as they perform the function of a pair of bellows for the inflating of the lungs. It watches your every movement as you cautiously advance; but raise your hand, and it immediately disappears among the grass. You have missed this time, but go a little distance off, and after some minutes return to the place, and you may see the selfsame Lizard in the same spot as

before; but it is more wary this time, so that your chances of success are even smaller.

Another time you are more successful, and manage, by a sharp movement of the hand, to catch your victim of course by the tail, or 'it may bite.' But look! what have you got? Nothing but a wriggling tail! The owner has vanished! Yes, it is quite true. These creatures have the strange power of rendering their tails so brittle as to be snapped off with the greatest ease, and they seem none the worse afterwards. With them life is dearer than an ornamental prolongation of the backbone. But the tail is not permanently lost; for, after a few seasons, a second tail will have developed to such perfection that it is scarcely to be detected from the original one.

Now examine the legacy so kindly left you by your departed friend. It still shows signs of life, especially when irritated. This seems very strange to us, who are so very dependent on the brain. Imagine the amputated leg of a soldier wriggling about on the battle field! But you must remember that lower animals have their nervous systems more evenly distributed; so that some of the functions which, in us, are controlled by the brain, may be performed in these, at least for a time, without the aid of that organ.

If you bend the tail in your possession, you will find that it is tough rather than brittle; and if you pull it, it does not easily break. Tame Lizards, too, never have brittle tails, and you may lift them by these hinder appendages as often as you like without ever breaking one. In fact, the tail of a lizard is brittle only when the creature finds it convenient to have it so.

Some years ago I caught a Lizard with a smaller tail growing out of the main one near its base. This was probably the result of a wound, for cases have been recorded where the tails of tame Lizards have been split part way across, and a new tail has grown out of the fracture.

Knowing now the peculiar nature of a Lizard's tail, you must try another mode of capture. Nets, as a rule, are useless; for these lively creatures always make sudden darts down into thick herbage when surprised, or else they run into a hole, the exact position of which they know too well. I have found nothing better than the hand itself, when hollowed into a cup-like form, and quickly brought down so as to cover the creature.

These Lizards are easily tamed, and may be kept in a glass case,

where their graceful movements and lively habits make them very attractive. You must feed them regularly. They are very fond of the various insects that infest plants. They will eat flies, and greedily devour small caterpillars that are not hairy. I have always found them very partial to spiders, and it is interesting to see them running round the case after a few very active ones that are thrown in just when they are hungry.

In nearly all instances where I have seen Lizards in confinement they have been kept in fern cases, but I am very doubtful as to whether the damp atmosphere and moist soil so essential for the majority of ferns is not very injurious to these creatures. In nature we almost invariably find them in elevated and dry spots; and I must say that I have been far more successful with those kept in a dry case with an artificial bank at one end, than with the few that I have kept in a damp atmosphere. Lizards require water to drink, but this is supplied to them naturally in the form of raindrops and dew, and if you give your tame ones a sprinkling of water once or twice a day, you will have the pleasure of seeing them lap up the globules with their pretty notched tongues.

During the early summer you may catch numbers of females, with young, for at this time they are less active and more easily secured. If you put one or two of these in your reptile house, and closely watch them, you may be able to see the young, about a dozen in number, struggling out of their membranous egg cases immediately after these have been laid. The young just hatched are lively little things, of a brilliant bronzy-black colour, and commence almost at once to search about for food. Feed them regularly with plenty of plant lice and you will be able to study their development, and observe their 'moults' and changes in colour.

Throughout the winter Lizards are torpid, but if kept in confinement in warmed apartments, the period of inactivity is much shorter than with the wild ones; and occasionally they will venture out of their hiding-places during mild weather even in mid-winter.

There is another Lizard that is often mistaken for this species; but it is not nearly so abundant, being found only in the South of England. It is known as the Sand Lizard (*Lacerta agilis*). It is larger and stronger than *Vivipara*, but is not nearly so docile, nor are its movements so graceful. It will readily bite its assailant, but, like the other English Lizards, its teeth are too small to penetrate the skin.

The colour of this species is so variable, that it is almost impossible to give a simple description by which it can be easily identified. Its chief distinguishing feature is the manner in which it brings forth its offspring, for it is truly oviparous. The female lays her eggs in sand, and covers them over lightly. She then leaves them to be hatched by the heat of the sun.

The beautiful Green Lizard (*Lacerta viridis*) of Guernsey and South Europe *has* been caught in Britain, but its presence here must be regarded as accidental.

While searching sunny banks for *Vivipara*, you will possibly meet with little snake-like creatures about a foot long. They are commonly known as Blind Worms or Slow Worms. So much do they resemble snakes that a close examination is necessary to prove

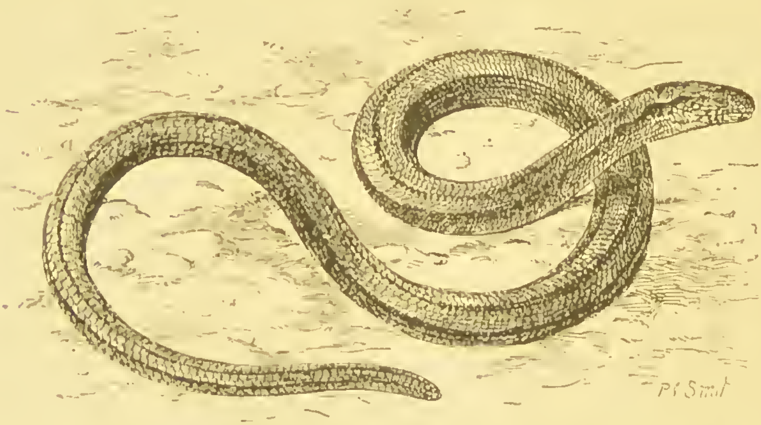

FIG. 352.—THE SLOW WORM OR BLIND WORM (*Anguis fragilis*).

that they are not. Watch a Slow Worm as it gracefully glides between the herbage, and you will see it constantly thrusting out its long and slender tongue as if this organ were used to enable it to feel its way. It is not a forked tongue like those of snakes, but is simply notched at the extremity just like the tongue of the Common Lizard. Look, too, at its bright little eyes, for it is not blind, and compare them with the eyes of Lizards. In both cases you will observe movable eyelids, a feature that true Snakes do not possess. Now take the creature into your hand, for it is perfectly harmless, and examine the arrangement of its 'scales.' You will see that they are all of very small size; but, as we shall find, the belly of a Snake is covered with a single row of very large oblong

scales. Then, again, if you are sufficiently skilful to prepare the skeleton of a Slow Worm, you will find that it is not *quite* limbless, for it has a rudimentary shoulder girdle and imperfectly developed fore legs, which, however, are not long enough to project beyond the general surface. Here, then, are four of the reasons we have for refusing the Slow Worm a place among the Snake tribe. It is a Lizard without visible legs.

The specific name *Fragilis* is applied to it on account of the readiness with which it will part with its tail—another feature, by the way, in which it resembles some of the Lizards and differs from Snakes.

The Slow Worm is very inoffensive, and seldom makes an attempt to defend itself with its little teeth. It is also easily tamed, and may be kept in the same case as the other Lizards. It requires no water, save an occasional sprinkling, so that it may sip the drops; and feeds readily on small slugs, earthworms, and smooth caterpillars.

The young are exceedingly pretty; they look like rather large, scaly, white worms, and are very active.

British Snakes

Snakes are absolutely limbless, and possess no trace of a shoulder girdle. They have also no breastbone; and the backbone, which extends throughout the whole length of the body, consists of a large number of *vertebræ*, often several hundreds, each of which bears two ribs. The teeth are small and pointed, and are curved inwards, so that they are of no use for masticating food, but are simply employed in holding the prey, which is always swallowed whole. The slender forked tongue is often confused with the poisonous fangs, but is possessed by all Snakes, whether poisonous or not, and is perfectly harmless.

We often read that Snakes have no eyelids, but this is hardly correct; yet they cannot close their eyes, and when dead, or sleeping, or even during torpidity, they seem to gaze on us with a kind of vacant stare. Their eyelids are really always closed, for they are transparent, and have grown into one over the eyeballs, thus forming a permanent protective layer.

There are only two British Snakes, unless the Smooth Snake, a few of which species have been captured in Britain, can be claimed as our own. But some regard the presence of this creature as

accidental, leaving us with only the Ring Snake and the Viper. Neither of these is known in Ireland, for, it is said, they were banished by St. Patrick out of tender regard for the safety of his people.

There is no reason, however, why the Ring Snake (*Tropidonotus natrix*) should have been turned out of the island, for it is perfectly harmless. It will occasionally bite its captor when seized or roughly handled, but its small teeth cannot do the least damage to an ordinary skin. Though rather large—often measuring three feet and more in length—it forms an interesting pet, and thrives well in confinement if properly managed.

Fig. 353.—The Common Snake.

It is impossible to say exactly where you may find Ring Snakes, but a hint or two may be given as to the nature of their haunts, so that you may be enabled to select likely spots. They are generally found in grassy spots near water, where they are not subject to much disturbance from the intrusion of such monsters as you and I; but yet they often approach very close to the dwellings of man, even venturing into cottage gardens, and laying their eggs on dunghills close to stables and cattle sheds. However, they seem very capricious in their habits; at times making their appearance in the most unlikely places, and at other times you may search most carefully in what seems to be a very suitable abode for such crea-

tures, and find nothing; or, perhaps, only a cast 'skin,' turned inside out, as the owner rid itself of the old coat by gliding through thick and coarse herbage.

The food of the Ring Snake consists of frogs, mice, small birds, and birds' eggs, all of which are swallowed whole! This seems impossible when you look at the small head and narrow neck of the Snake, but the lower jaw is jointed in such a manner that the gape is remarkably wide, and the neck admits of a wonderful enlargement. Young frogs disappear down its throat quite rapidly, and are generally disposed of head first; but large frogs are often seized by a hind leg while in the act of beating a hasty retreat. In this case the Snake may not trouble about turning its prey round, but will take it just as it comes; and although some time is occupied in conveying such a large morsel into its stomach, yet the frog is usually alive on arriving there.

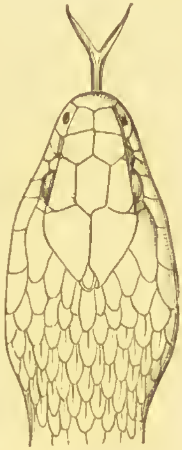

Fig. 354. Head of the Common Snake.

Sometimes the Snake may be seen enjoying a bath, a luxury that is often indulged in during the hot weather. Its body is coiled together in the water, perhaps entirely submerged except the head, which must always be exposed for breathing. In this position it will watch for newts, and occasionally it swims on the surface of the water.

Its eggs are white oval bodies, about the size of a blackbird's egg. They are from fifteen to twenty in number, and are laid separately, but all within a short space of time. They are covered with a moist sticky substance at first, but this soon dries, thus cementing the eggs together at all points where they touch each other. The female Snake is pretty careful in the selection of a suitable spot in which to deposit her eggs; sometimes choosing a dunghill or a heap of decomposing vegetable matter, the warmth of which assists the development of the young; or she will lay them on a patch of land so situated as to catch the sun's rays during the greater part of the day. Having bestowed so much care on her future offspring, she leaves them to look after themselves, and does not seem to distinguish her own young from those of another parent.

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Our other Snake—the Viper or Adder (*Pelias berus*)—is quite common enough, considering that its bite is poisonous and generally leads to rather unpleasant results.

One who is not thoroughly acquainted with this and the last

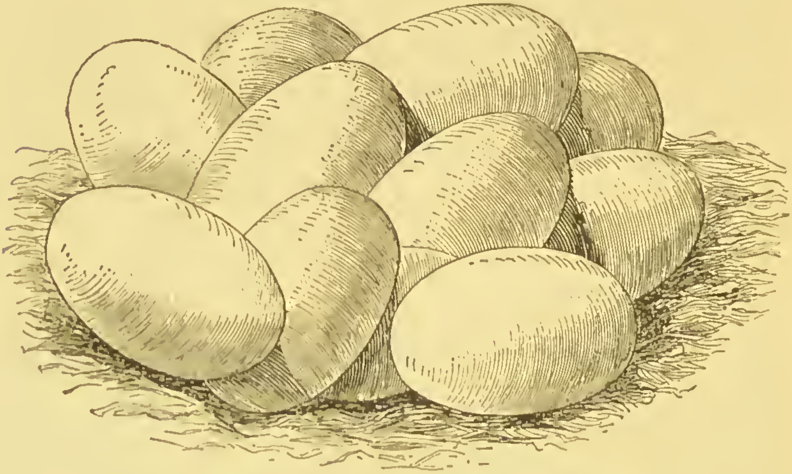


Fig. 355. Eggs of the Common Snake.

species may find it difficult at first to distinguish one from the other; and as a mistaken identification may be the source of much trouble and pain, we shall do well to note at once the chief distinguishing marks by which we can know them.

In the first place, there is usually a difference in the nature of their respective haunts; for, while the Ring Snake delights in moist situations, the Viper chooses very dry spots, where it can sun itself among the half-withered vegetation. But when we come to consider the differences in the form and colour of the creatures themselves, we certainly meet with a little difficulty, for both are very variable in their colouring, and on this account we are very liable to mistake one for the other, especially as we generally have to identify them at some little distance and in a short space of time. It will not do to pick an Adder up to see if it is a Ring Snake, and if we hesitate in coming to a decision the creature will disappear before the verdict is given; and, again, if we are to capture it, it is absolutely necessary that we should know what we are capturing, for that will determine the way in which we shall set about it.

The chief differences, then, are these: the Ring Snake is usually much larger than its venomous relative, the full-grown specimen

being seldom less than two feet, and often more than three feet in length, while the Viper is rarely much longer than two feet. The head of the former, though larger than that of the Viper, is narrower in the front, and the Viper's head is marked with dark patches that are said to resemble the 'skull and bones' on the thorax of the Death's Head Moth. One of these marks resembles an inverted V—the initial letter of the creature's name. But perhaps the most easily detected distinction lies in the colouring of the back. That of the Viper presents a broad zigzag black line down the middle of the back from head to tail, but the upper surface of the Ring Snake is of a brownish grey or ash tint, with two rows of black spots. The leaden hue of the single row of large scales along the belly of the Ring Snake may also be useful as a distinguishing mark.

Do you desire yet another distinguishing characteristic of the Viper? Then make yourself acquainted with its venomous fangs—an eye acquaintance only, of course. If ever you have an opportunity of examining the mouth of a dead Viper, you will be able to make out, by an easy dissection, the nature of its dangerous weapons of offence and defence. Projecting from the upper jaw you will discern a pair of long curved teeth which may be made to lie in grooves in the gum behind them, or may stand out at right angles to the jaw. These are the dreaded fangs. Each fang is perforated from its base almost to the tip, where there is a little slit on the outer side. You may also be able to make out a delicate tube that connects the hollow tooth with a little gland, some distance behind, in which the venom is prepared and stored.

Fig. 356.—Head of the Viper.

When the Viper is about to attack, it elevates its head, and then, with a blow rather than a bite, plunges its fangs into the flesh of its victim. It thus makes two small punctures, hardly noticeable at first; but the poison injected into these little wounds effectually makes itself known almost immediately.

Agricultural labourers and others who frequently meet with Vipers during the course of their daily work will tell you awful and thrilling tales concerning the deadly effects of the Viper's bite; but, like the marvellous stories of toads and newts, they are generally

without foundation; and it is very doubtful whether we have even one well-authenticated instance of a case that terminated fatally. Of course you will understand that I am speaking of human victims. The small creatures which form the Viper's food are very quickly killed by the powerful venom.

Are there any among my readers who take such interest in this Reptile, and, at the same time, possess such an amount of courage, that they would like to search it out in its haunts? If so, be careful that you are well equipped for the task. If you know how to set to work, you need never be bitten, even though you bring home your captives alive. Good boots, high leather leggings, leather gloves, a tough stick, a deep holland bag, a piece of string, and a small bottle of strong liquid ammonia are all you require. If you do not want live specimens for your case, your work is simple enough. Strike the Viper on its head, lift it on the end of your stick, drop it into your bag, and tie it up. But when an uninjured specimen is coveted you must be exceedingly cautious. A surprised Viper will always retreat unless attacked, and it will allow you to follow it a great distance; but, should you accidentally step on one, it will go for your shins without mercy; hence the value of good leggings. I have found no difficulty in securing live Vipers by the following simple plan. First remove it far from its retreat by hurling it away on the end of your stick, and, if possible, get it on an open and bare patch of ground. Now let it attack the stick till both its store of venom and its physical energy are pretty well exhausted. Then pick it up on the end of your stick and drop it into your bag.

Remember that this or any other mode of capturing live Vipers is somewhat dangerous, and it is always advisable to be prepared for emergencies. Should you be bitten, however slightly, suck the wound immediately as powerfully as you can, or get some one to do it for you; and also rub ammonia well into the place.

The Viper is one of the ovo-viviparous Reptiles. Its young escape from the egg immediately after, and sometimes even before, emerging into the world. And now arises a most interesting question—one that has occupied the minds of many naturalists for a considerable time, and which has not yet been cleared up to the satisfaction of all. Does the Viper protect its young by swallowing them? We have not the space to quote the evidence that has been given by various observers on both sides of the question. Many aver that they have seen a whole brood rush hastily down their

mother's throat when threatened with danger; and some have even satisfied themselves that their eyes were not deceived, by killing the affectionate mother and cutting out the lively little creatures. Yet there are those who doubt the story, and say that the young so liberated had hatched within the abdomen of the parent, and had never before seen the light. However, as long as the statements are regarded as wanting confirmation, we may all help to finally settle the dispute by our own close observations when opportunities arise.

Like all other British Reptiles, Vipers hibernate through the winter months. On the approach of cold weather they seek out a snug and dry hole, such as the hollow of a tree, and there several coil themselves up together, remaining without food of any kind till the following spring.

Preserving Reptiles

The simplest and perhaps the best method of preserving Reptiles is to keep them in spirit. This does not destroy their natural colouring to any appreciable extent, and always retains them in good condition for dissection at any future time if a study of their internal structure is desired. In some cases I have observed that the undiluted spirit extracts water from their bodies, thus causing them to shrivel up more or less. It will be advisable, therefore, to use a mixture of spirit and water, about equal quantities of each; this being quite as good a preservative as the strong spirit, providing no loss by evaporation is permitted.

If you are desirous of mounting your Reptiles, or of keeping them in any way as dry specimens, they must be skinned and stuffed. The skinning is not a difficult matter, but you have to be very careful not to damage the 'scales.' First make a short incision along the belly from the vent forward. Then loosen the skin all round the body at this point, and snip the body in two. Next liberate the hind half by gently pulling the skin inside out over it, and cut off the extremity of the tail, which is allowed to remain in the skin.

Now skin the fore part in the same manner till you reach the head. Here the body is cut off close to the skull, the brains extracted, and the flesh of the skull dissected away. Dress the whole of the skin with a preservative, which may be any one of those recommended for Birds, and stuff the skull with cotton-wool. Now turn the skin

right side out, and fill it up with a mixture of sawdust, fine sand, and a little of the preservative powder.

After sewing up the incision neatly, you can push a sharpened wire completely through the body. This will enable you to bend it in any position you may fancy.

The above directions apply more particularly to Snakes; but the process is the same for Lizards, except that the limbs have to be cleared and preserved; and this is done much in the same manner as directed for Birds on page 261.

Plate IX

CHAPTER VII

BRITISH BIRDS

Sometimes, when making mention of a certain class of animals for the first time, it is necessary that a clear definition should be given in order that they may not be confused with those of another class. But this seems hardly necessary now, for we are to deal with *Birds* —and everybody knows a bird when he sees it. Still it may not be superfluous to point out the chief characteristics in which they differ from the other *Vertebrates.*

How, then, shall we define a Bird ? Shall we say 'a vertebrate animal that flies' ? But so do the bat and the flying fish, while some birds do not fly at all. Try again. A biped vertebrate ? So are you and I. A toothless vertebrate ? So are some of the insect-eating mammals. Is there any *one* characteristic by which *all* birds may be distinguished from *all* other animals ? Yes, there is ; for they are the only living beings whose bodies are clothed with feathers.

If you examine any one of our feathered friends, you will find it possessed of two distinct kinds of feathers. First, there are the strong *contour* feathers, consisting of a stiff axis and expanding vanes, always arranged on certain definite tracts of the body. Then there are the soft and downy feathers covering the remainder of the surface. In very young birds the down feathers only are seen ; and it is interesting to note that, with adult birds, the less they use their wings the larger the proportion of down in their plumage. In fact, some of the foreign running birds have no true contour feathers at all.

Birds and Mammals are the only warm-blooded animals, and the blood of the former is warmer than that of the latter by about eight or ten degrees, for the temperature of birds ranges from 106° to 108° F. This difference may be accounted for partly by the superiority of the clothing, and partly by the extensive development

of the breathing apparatus. We, together with the other mammals, breathe by means of our lungs alone; but birds possess air cavities in different parts of their bodies which communicate with the air

Fig. 357.—A Contour Feather.

a, barrel; *b*, square rachis or axis; *c*, vanes.

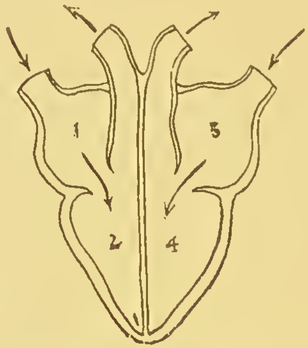


Fig. 358.—Diagram of the Heart of a Bird.

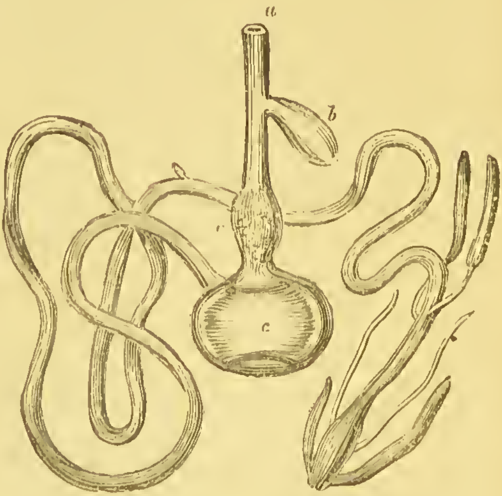


Fig. 359.—The Digestive Organs of a Bird.

a, œsophagus; *b*, crop; *C*, stomach; *c*, gizzard.

tubes of the lungs. Even their bones, or rather some of them, are hollow, containing air instead of marrow; and thus the supply of oxygen—the great heat producer—is widely distributed.

It will probably occur to the minds of my readers that these air

cavities serve another purpose, namely, that of rendering the bodies of birds light, and so better adapted for flying.

The heart of a bird contains four cavities; two of which—the *auricles* (fig. 358, 1 and 3)—receive the blood that has just completed its circulation; and the other two—the *ventricles* (fig. 358, 2 and 4)—acting after the manner of force pumps, start the blood on a new round.

Birds have no teeth, but they have a substitute in the form of a gizzard or masticating stomach. This consists of two thick and strong masses of flesh covered with a tough and horny skin. In it there are always some grains of sand or small stones; and, as the two parts rub together with an incessant motion, the food substances are ground up as effectually as if between a couple of millstones.

The skeleton possesses many points of interest. Birds have more bones in their necks than we have, and that accounts for the greater freedom and variety of the movements of the head. We, with our seven neck bones, cannot look behind us without turning our whole bodies to some extent; but birds, with often more than twenty bones, can easily give their heads a complete half-turn without moving their bodies at all. The breastbone too, is of peculiar construction. It is provided with a prominent keel, to give attachment to the powerful muscles that move the wings. But those birds that do not fly, such as the ostriches, do not require to have these muscles so strongly developed, and consequently have no keel to the breastbone. Then, again, we find but few ribs in the skeleton of a bird; and the formation of the feet is peculiarly adapted to the habits of the creature, as we shall presently observe. The accom-

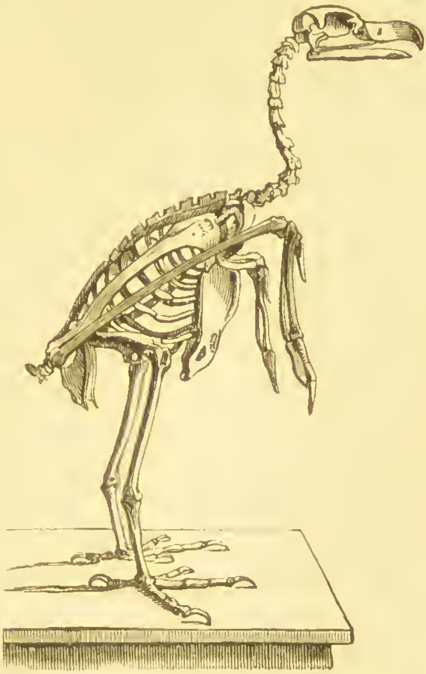


Fig. 360.—The Skeleton of a Bird.

panying sketch of the skeleton will at once reveal other interesting features which we cannot dwell on.

Now let us see what we can do in the way of collecting and preserving some specimens, and thus obtaining a closer and more practical acquaintance with our British species.

Collecting and Preserving Eggs

There is only one way of getting thoroughly acquainted with birds, and that is to search them out in their haunts, examine their nests and eggs, and watch the progress of the broods of little ones.

Let us start out with this object in view. Choosing a fine dry day in spring or early summer, we start off, provided with a pair of strong leather gloves to assist us in pushing our way through prickly or thorny bushes, a number of small boxes to contain our eggs, some wadding to wrap them in, and, if possible, a binocular glass to help us to watch the movements and to discern the colours of the birds.

It is rather a difficult matter to decide as to what kind of ground we shall select for our hunt, since the haunts of the different species are so very variable; but perhaps we cannot do better than select a spot of wooded country thickly overgrown with bushes of all sizes and intersected by a stream—a rugged and wild spot, if possible, with numerous hollows and banks, and here and there a small grassy space.

Some birds sit very closely on their nests, and will not fly off unless we approach very near; so we walk very quietly among the bushes, tapping them with a stick as we pass. In this way we drive many from their nests close at hand, and generally find but little difficulty in discovering their homes. But often we may fail, even after a very diligent search both in and under the bush. In such a case we retreat to an adjacent hiding-place, and watch for the return of the old bird, noticing as far as possible the exact locality of the resting-place. Then another and very cautious approach may give us a better clue to the position of the nest.

Often we see a bird carrying some nest-building material in its beak. Then the binocular is brought into service for the purpose of finding out where the home-making is going on. Some nests are very easily found by simply looking into the larger bushes, without any knowledge derived from the movements of the parents; but, as

a rule, much time is wasted in this way, and we should do much better to work on the hints suggested by the behaviour of the birds themselves.

If the presence of a nest is suspected in a large bush, our best plan will be to push our way underneath and look upward; for, looking in this direction, with the sky as a background, any collection of materials amidst the leaves and branches will be far more easily detected.

A glance at our table of British Birds will show us that we must by no means confine our attention to bushes and trees. In fact, the sites chosen are so varied in character, that, unless we regard the birds as our guides, we are quite at a loss as to where we shall search. Old hollow trees, holes in walls, rabbit burrows, corn fields, hedges by the roadside, holes in the banks of streams, crevices of rocks, and among reeds in a marsh, are only a few of the many spots chosen by birds.

On the discovery of a nest, or of any peculiar habit of a bird that has been watched, notes should be made of points of interest. In the case of eggs, one only should be taken from each nest. This should be immediately wrapped in a piece of wadding and placed in a small box, the cover of which is numbered. An entry should then be made in the note book, showing the number on the box, position of the nest, materials of which it is built, the number of eggs in the 'clutch,' and any other useful information.

As soon as possible after arriving home, your eggs should be prepared for the cabinet. For this purpose you will require a few

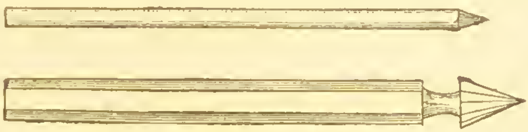


FIG. 361.—EGG DRILLS.

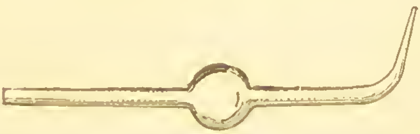


FIG. 362.—BLOWPIPE FOR BLOWING AND WASHING EGGS.

egg drills of different sizes, one or two glass blowpipes, a basin of water, and some blotting-paper. The drills and blowpipes may be obtained from any dealer in natural history objects, but the latter

can be easily made by drawing out a piece of ordinary glass tubing after softening it in a gas flame. They are far more convenient if bent into a large angle at the small end, and a bulb at the middle part is a great advantage, but not necessary. When your apparatus is quite ready, deal with each egg as follows:

Lay it down on the wadding in which it was wrapped, and examine it till you are satisfied as to which side best shows the characteristic markings; then pierce the side opposite this with a fine needle, selecting a point just midway between the two ends. Now take a drill of suitable size, and turn it alternately right and left between the finger and thumb till the hole is large enough to discharge the contents. It is surprising how small a hole will allow of this. In the case of small eggs, it should seldom be more than a sixteenth of an inch in diameter, and an eighth is generally sufficient for the largest of eggs. While drilling, the egg should be held over a vessel of water, so that, should it fall, no damage will be done.

Now turn the egg till the hole is beneath, holding it by applying finger and thumb to the two ends, and blow upwards into it, keeping the jet of the blowpipe *quite outside*, and allowing the contents to fall into the water below. In this manner you speedily empty the shell. Next, put the jet of the blowpipe into clean water, and suck up the liquid till it is quite or nearly full. Blow this water into the shell, turn it over, and then blow in air till the water is expelled, just in the same manner as that in which you sent out the original contents. Repeat the washing, if necessary, till you are satisfied that the interior is perfectly clean. If now the *outside* of the shell is stained with the yellow of the egg, wipe it off gently with a little pellet of cotton-wool, and then place the empty egg, hole downwards, on a piece of blotting-paper to drain.

Never wash an egg unless *very* dirty; for, by so doing, you may often remove some of the natural markings—many eggs are seriously damaged by washing, and few are in the least improved by it. A *little* dirt often adds to the natural appearance.

The old plan of varnishing the egg should never be entertained for an instant; nor should we ever do anything to improve (?) its appearance; for our object in making the collection is not to produce a set of brilliant ornaments, but a group of objects to assist us in the study of *nature*. We no longer applaud the reckless schoolboy when he exhibits a yard or so of eggs, blown with an ugly hole at each end, and dangling on a coarse string.

An egg collector will occasionally meet with incubated eggs, the blowing of which will cause considerable trouble. If freshly laid specimens of the same kinds can be secured, it will be better not to attempt the clearing of these; but if the incubated eggs are valuable, and there seems to be but little chance of obtaining newer ones, then they may be cleared as follows: Make the hole much larger than usual, and remove as much as possible of the contents with the blowpipe as before directed. The projecting solid portions should then be cut off with a fine pair of scissors. Repeat both tho blowing and cutting in this way till all the interior has been removed.

Cabinet for Birds' Eggs

Almost any kind of shallow box will serve for storing your eggs; but, of course, the general neatness of the affair is a matter for consideration. You may obtain shallow wooden boxes from your grocer, and these, neatly papered both inside and out, will answer your purpose admirably. Whatever be the number required, all should be of the same size as regards length and breadth, but the depth may vary according to the size of the eggs they are to contain. The eggs may simply be arranged on a layer of wadding, but it is far better to have your boxes divided into a number of partitions. This may be done by fixing strips of cardboard at convenient distances apart, or you may construct a number of little cardboard trays of such a size that they completely fill up the space.

The accompanying illustrations show how the little cardboard trays may be easily constructed. First mark out a piece of card as

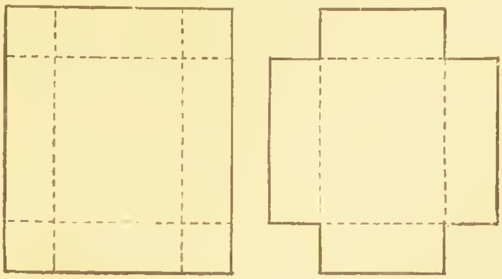


FIG. 363. SHOWING HOW TO MAKE THE CARD TRAYS.

shown in fig. 363, the central portion being the size of the bottom of the tray, and the border the intended depth. Cut out the corners, and then cut *halfway* through the card on the dotted lines. The

edges are now easily turned up in position, strips of paper glued at the corners, and the tray is complete.

As your collection extends, you will often find it necessary to rearrange your specimens to make room for the new comers, for you must never permit your store boxes to run into disorder. If you are a very ambitious collector you may start by providing a tray for the egg of each British bird, excluding, perhaps, the very rare kinds. But, if you do this, the number of blanks will at first be appalling, and you must remember that you have thus set yourself a task of years, unless, with a deep and well-filled purse at your command, you seek the kindly assistance of the ever-obliging dealers.

A true naturalist never approaches a dealer without a feeling of very great reluctance. He always attaches far more value to the specimens collected than to those bought, and appreciates highly the knowledge gained during his various expeditions. Still there are sometimes blanks of years' standing that seem as if they never will fill up, and he *may* then be tempted to apply to a dealer for help, rather than remain a stranger to the absent friend.

At first you may be satisfied by arranging your specimens according to our table of British Birds; placing the name of the order at the head of each of the five natural divisions, and the name of the species *beneath* each egg. But when your knowledge has increased, you will probably desire to study the subdivision of the Orders into numerous Families. For this purpose you may make use of 'Wharton's List of British Birds' as a useful guide.

In addition to the name, each egg should have a number attached, referring to the entry in your note book, and in each case, whether the specimen is of your own collecting or not, this entry should give its origin, and other useful and interesting particulars.

Bird Preserving

This book may probably fall into the hands of many who would like to know how birds may be preserved so as to form a permanent collection for study and reference. Well, in the first place, it will be necessary to decide on the form which the proposed collection is to assume. If the space to be occupied by the specimens is limited, or if the object of the collection is to provide a means of study only, or if the income of the collector is only a moderate one, then he had

better be satisfied with specimens 'in the skin;' that is, his birds should be skinned, and the skins preserved and stuffed to lie in a cabinet or in store boxes. But, if provided with abundant space and a good purse, he may go beyond this, and mount his birds artistically in glass cases. In most instances, however, I should not hesitate to strongly recommend the former plan. For, while the mounted specimens in air-tight glass cases *may* form pretty ornaments, and *may* (but frequently don't) illustrate very interesting attitudes natural to the birds, those preserved in cabinets in an unmounted condition always admit of a close examination, and their parts can be conveniently measured when desired.

Having settled this, our first problem, we must set to work; first, to get together the necessary implements and materials, and then to secure our birds. It is *possible* to do good work with a sharp penknife and an ordinary pair of scissors; but, if circumstances permit, a few scalpels of different sizes and a good pair of dissecting scissors should be obtained. Beyond this we shall require no other tools save a few needles and brushes of different sizes.

Now for the materials—cotton, thread, plenty of cotton-wool, plaster of Paris, iron wire of various thicknesses, benzoline, a preservative powder, and a preserving soap. The last two may be obtained ready made from various dealers; but we can prepare our own as follows:

Preservative Powder

Whiting . .	4 parts	Naphthaline . .	1 part
Burnt alum . .	2 ,,	Oak galls . .	1 ,,

Reduce the above to a very fine powder, thoroughly mix the ingredients, and store in an air-tight bottle or tin.

Preservative Soap

Whiting . .	2 parts	Soft soap . .	1 part
Burnt alum . .	1 part	Naphthaline . .	1 ,,

Reduce the solids to a fine powder; mix the whiting, alum, and soft soap with sufficient water to form a thick paste, and stir them in an old saucepan, over a slow fire, till uniformly mixed. When nearly cold, throw in the naphthaline and stir again. The mixture must be kept in a well-stoppered bottle or in an air-tight tin.

It will be observed that none of the ingredients in the above mixtures are poisonous; yet, if properly applied, they will effectually

prevent the intrusion of vermin in well-stored specimens. Only the powder is necessary for the preservation of small birds; but for the larger species it will be advisable to use the soap as a paint, and then to dust on the powder as well.

Some authorities seem to think that the presence of a powerful poison is absolutely necessary in all preservative mixtures. I am not of that opinion myself; still, I will give examples of such preservatives, as the reader may possibly like to try them and judge for himself.

Arsenic Powder

Mix equal parts of powdered 'white arsenic' and burnt alum.

Arsenical Soap

White arsenic .	4 parts	Soft soap . .	8 parts
Whiting . .	12 ,,	Camphor . .	1 part

Moisten the camphor with one or two drops of spirit and reduce it to a powder. Then powder the arsenic and whiting separately. Put the soft soap and whiting in an old saucepan with a very little water, and stir well over a slow fire till nicely mixed. Remove from the fire, and, when cold, add the arsenic slowly, stirring all the time. Finally, add the camphor and mix again.

The saucepan used in making this soap must never be employed for any other purpose afterwards, and both the poisonous preparations should be carefully put away in bottles or tins with very conspicuous labels, on which the word 'poison' is written in large letters. This is more particularly necessary when the operator has younger brothers or sisters. Care must be taken not to allow the arsenical mixtures to touch the skin if cut or torn in the slightest degree; and under all circumstances the hands should be well washed after coming into contact with them.

Should the reader desire to save himself the trouble of preparing these poisonous mixtures, he may procure them ready made from any dealer in natural history appliances, or get them mixed for him by a chemist.

Now that all the necessary preparations have been made, how shall we obtain the specimens for stuffing? Of course it is possible that the reader himself possesses a gun; but, if such is the case, I would strongly urge him not to slaughter birds for mere sport, but to kill only those that are necessary for purposes of study. In many cases only one of a kind is required, even in a complete collection;

but there are often interesting differences in the sexes, or variations in the plumage of different seasons, that should be represented in the collector's cabinet.

A few examples will suffice to make this point clear. The summer plumage of the common House Sparrow is very different from its winter dress, and there are very marked differences between the summer and winter feathers. Thrushes and Larks vary but very little, so that one single specimen of each species is generally sufficient. The Buntings and Starlings present very different aspects in spring and winter, and should be represented in the attires of both these seasons. The specimens of Hawks should, as a rule, include both male and female, more especially on account of the superior size of the latter. Then, again, it is very instructive to watch the development of the feathers, and the changes in colour exhibited by the same species as it passes from the nestling to the adult stage. For such a purpose a series may be preserved, including a young bird 'in the down,' and a few others at different stages of growth.

If you have not a gun yourself, you will generally have but little difficulty in procuring suitable birds at a very low cost. You can even make a fairly good start with the smaller kinds that you find displayed in the poulterer's shop, but you must be careful to select those which have sustained no further damage than that produced by the shot. But the best thing you can do is to make the acquaintance of a gamekeeper or a farmer, either of whom will be willing to supply you with the 'vermin' brought down, and that for a mere trifle.

For your first attempt you had better take a bird of rather small size, but not too small. The Starling or Thrush will serve very well to begin with.

Well, we will now assume that everything is ready, the bird included. Arrange all your implements and materials before you, and perform your operation with the following instructions as your guide. Don't trust your memory for anything, but consult the directions for each stage as you proceed. It is your first attempt, so work slowly and carefully, and with as much patience as possible. Your first bird will probably take up much time, and may not turn out well after all; but care and patience will enable you to succeed in the end, and with these qualities brought into play there is no reason whatever why you should not eventually become an expert taxidermist.

Lay your bird on a sheet of white paper, and push a little plug

S 2

of cotton-wool into the slit at the roof of the mouth to prevent any blood from oozing out through the nostrils. Then fill the mouth itself with the same material, and also plug up the shot wounds if there are any.

Now place the bird on its back with its head towards you, and part the feathers from breast to vent so as to expose the bare skin. Then cut the skin from the lower end of the breastbone to the vent with your pointed scissors; or you may do this with your scalpel, working with the edge turned upward. Great care must be taken not to cut deeper than the skin, especially as you approach the vent; for here the wall of the abdomen is very thin, and if you cut through this the digestive organs will project and cause much trouble by adhering to the feathers. Now raise the skin, and gently force the flesh away from it with the *handle* of your scalpel or any other small *blunt* tool. Work on in this manner on one side till you reach the leg. Take hold of the leg on the outside, and push it in till the knee is well exposed. Push the skin away from this joint, and then cut the leg completely through. Do the same on the other side; and when both legs are dangling free from the trunk, gradually work off the skin round to the back, dusting the surface of the body and the inside of the skin liberally with plaster of Paris to prevent the feathers from sticking.

After loosening the skin completely round, work it gently towards the tail, but not too far, or the tail feathers will be loosened. Cut through the end of the bowel at the vent, and then through the tail, bone included, leaving a small 'parson's nose' as a foundation for the feathers of the tail.

Now lay hold of the stump of the tail with finger and thumb or a pair of forceps, and let the body hang head downwards. Push (not pull) the skin off the trunk, working it gently down with the fingers, till you reach the wings. These are to be dealt with exactly in the same manner as the legs, cutting them off at the *shoulder* joints.

You will now find that the skin peels off very easily over the neck and head till you reach the ears. Here the scalpel comes into service again. Cut very carefully round the membrane that covers the ear opening on each side, and then push back the skin till you have gone just beyond the eyes. Cut through the membrane round the eye sockets, and then scoop out the balls.

The skinning has now been completed, but there still remains a considerable amount of clearing to be done.

First cut off the head at the first joint of the neck, and so dispense

with the trunk. Then cut away the back (not upper) part of the skull and remove the brain. Also remove all the flesh that remains attached to the base of the skull.

You must now work backwards, clearing away all decomposable matter and applying the necessary preservatives as you proceed. Wipe out the eye sockets perfectly clean, paint them with your 'soap,' and then dust with a little preservative powder. Roll up two little balls of cotton-wool large enough to completely fill the sockets. Insert them in their places, and bring the skin over them in its natural position after applying preservatives both to it and the skull. Preserve and stuff the cavity of the skull just as you did the eye sockets.

Now attend to the legs and wings. The former must be skinned as far as the end of the first bone, and all the flesh removed. The wings must be similarly cleared to the end of the *second* bone—that is, as far as the 'bend' or wrist. Apply the preservatives liberally to the bone, push the limbs back in their places, and pack a *very little* cotton-wool to take the place of the flesh removed, being very careful not to distend the limbs beyond their natural size.

Next clear the flesh from the tail as completely as possible, and apply plenty of soap and powder. Then see that all fatty matter is scraped off the skin of the body, and apply preservatives to every part.

You have now to put your skin right side out. To do this press the head in till you can feel the beak in the midst of the neck feathers. Then take hold of the beak and pull gently till the skin is completely turned. You will find that the feathers are very much ruffled, but they may be set in place by gently stroking the whole skin from head to tail with a wad of cotton-wool.

The stuffing must next be completed. Roll up a wad of wool just large enough to fill out the neck to its natural size, or, preferably, a little less than this. Then prepare the body. This must be egg-shaped, and made up very firmly; not simply pressed into the proper form, but well threaded through and wound round with strong thread. It must be a little smaller than the body of the bird, and inserted so that the narrower end is at the tail.

Your skin has now been 'made up,' and only requires the finishing touches to render it fit for the cabinet. First see that all the feathers are in their right places. If not, they must be set right by stroking with a pad of cotton-wool, using also a pointed instrument, if necessary, to arrange those that do not readily fall into

place. If any of the feathers are stained with blood, or matted together, or marked with dirt of any kind, they should be carefully washed with cotton-wool and warm water. Benzoline may also be used with advantage, for the purpose of removing all traces of grease from the feathers.

After the plumage has been thus washed with either water or benzoline, your bird will be a most unsightly object, and may appear as if it could never be set right again. But dust it over with plenty of plaster of Paris, and set it aside for an hour or two to dry. Then, on blowing off the plaster, and brushing down the feathers with *dry* cotton-wool, you will find it beautifully cleansed and quite natural in appearance.

Nothing remains now but to set the stuffed skin aside for a week or two previous to giving it its resting place in your cabinet. It should be rolled up in wadding, with the legs lying neatly over the tail, and placed in any dry and airy place for this purpose.

It will be observed that I have said nothing whatever about sewing up the incision in the skin. This is not necessary unless the bird is to be mounted; for, if the body wad is not too large, the skin will close over so perfectly that the cut will not show.

Before placing the 'made-up' skin in your cabinet, a label containing date and place of capture and other particulars that are likely to prove useful should be tied to the legs.

The directions just given for skinning and preserving will apply to nearly every bird, but there are a few species that require some slightly different treatment. Thus the heads of Woodpeckers, Ducks, and Geese cannot be passed through the skin of the neck in the usual way. In the case of the first-named, and any other small birds that present the same difficulty, it is generally possible to clear the skull of the decomposable matter without skinning to the eyes; but the larger species should have a cut made either in the side of the neck or on the top of the head, so that the skull may be brought out and properly dealt with. Of course the incision should be neatly stitched up after the skull has been replaced.

The best time to skin birds is a few hours after death, during the period of *rigor mortis* or death-stiffening. When this cannot be conveniently done, the specimen may be set by for a few days, if necessary, during cold weather, but such delays should be strictly avoided during the summer, for decomposition may set in, rendering the operation not only unpleasant but decidedly dangerous.

At times it may not be convenient to stuff a skin right away.

Under these circumstances you should see that it is as free as possible from perishable matter, and pack it away in a well-fitting box with plenty of preserving mixture till you have time to attend to it. When at last your opportunity comes for stuffing the skin, you will find that it is very dry and somewhat shrivelled, so you must put it through a relaxing process. Fill the skin with moist sand or tow, and bury it completely in a box of moist sand, letting it remain undisturbed for two or three days. I need hardly mention that the sand should be well washed to remove all traces of dirt, and, if salt-water sand, to extract the salt. When you turn out your skin you will probably find it nicely softened and in a fine condition for stuffing; but, if not sufficiently pliable, it must be replaced in the sand and kept there for another day or two.

Now let me give a little advice concerning your ornithological store boxes or cabinet. Each tray or drawer should fit well, and be divided into partitions of suitable sizes to receive the specimens you have prepared. Lay each bird on a bed of cotton-wool, and be careful to insert a very liberal supply of some kind of insecticide. This may consist of a layer of powdered naphthaline at the bottom of each division, underneath the cotton-wool, or a piece of camphor in the corner of each cell. As an additional precaution you may dust over your specimens with one of the preparations known as 'insect powders.' But, whatever steps you take, remember that your collection is always in danger of being destroyed by one or more of the numerous museum pests. Every now and again you must turn over your collection, and examine each specimen separately, renewing the supply of preservatives whenever necessary. Should you meet with any signs of plunder, remove the infected specimen at once, and do not replace it in its cell till you are certain that all life has been destroyed. A baking of a few hours' duration in a gentle oven will effectually destroy the intruders, and will do no harm to the bird unless the temperature has been too high.

Another source of danger is dampness. Never store a specimen till it is perfectly dry, and remember that several weeks are sometimes necessary to completely dry a skin. One single damp specimen may cause a dozen or more to become mildewed.

Should you like to try your hand at mounting, proceed with one of the stuffed birds as follows: Cut a few pieces of iron wire of suitable diameter—Number 22 size for a small bird. One piece for the tail should be about two or three inches long, another of about

four inches for the head and neck, two more of the same length for the legs, and one longer piece for the wings. See that each is perfectly straight, and then file off one end of each to a sharp and smooth point. Push the tail piece through the tail, and send it well into the body wad to secure a good hold. The head wire must be forced through the top of the skull, down the neck, and then for some distance into the body. Spread out the toes of one of the feet and straighten out the leg. Then take a fine stiletto and make a hole through the bottom of the foot, passing the instrument inside the leg bone. Now push one of the leg wires through the leg into the body. Do the same with the other leg, and pass both these wires obliquely into the body wad in such a manner that they cross near the shoulders. The wire for the wings should be passed through the outer quill of one wing, then through the shoulders, and out through the corresponding quill of the other wing. This will enable you to expand the wings fully, but the wire may be dispensed with if you intend to mount the bird with wings closed, substituting for it a few pins to keep them in position during the drying.

Press a little putty into the eye sockets, and insert the eyes. These should be just large enough to fill the space left in your skin; and if the aperture was stretched during the skinning, the membrane must be brought over the artificial eye with a needle till it is exactly of the natural size.

Now bend the wires till you have each part in the desired position, and see that you do not fall into the common error of making the legs too long. If the wings are to be expanded, a few pieces of card may be pinned against them to fix the feathers evenly in their proper position. The tail feathers, too, should be nicely spread, and kept in position by strips of card till the specimen is quite dry. If your bird is one of the aquatic species, you must also expand the toes and pin them firmly to pieces of cork or soft wood.

See that the attitude of the bird is a perfectly natural one. To do this you should compare it with a living bird of the same kind if possible, and let it show one of the characteristic attitudes of the species as accurately as you can. If you cannot study from life in this way, you had better consult the illustrations in some good book, or, better still, pay a visit to some museum where well-mounted specimens are exhibited. The splendid collection in the Natural History Museum at South Kensington will supply you with some capital copies, and every young collector should make himself familiar with this delightful building, full of natural treasures of all

descriptions, if he resides in or near London; and if not, let him write it at the top of his list of the anticipated 'sights' when he is making preparations for a 'run to town.'

Only one thing more remains to be done. Your bird is skinned, preserved, 'made up,' wired, and set. Now you must work its body into the graceful natural form that you wish it to retain on drying. Then thrust several rather large pins into it at different points, and wind it round and round with thread, setting every feather into its true position as you proceed. If the bird is to be mounted with closed wings, then the thread will be bound round them to keep them closely applied to the body. The bound specimen must then be put in a dry and airy place for a few weeks, the length of time varying with the temperature and condition of the atmosphere. When perfectly dry, remove the binding, and mount your bird according to your fancy. If it is to be placed on a perch of any kind, the projecting leg wires may be run through the perch, thus giving a good hold; but any other wires that stand out visibly must be snipped off with a pair of cutting pliers.

Classification of Birds

It would be out of the question to give, in our limited space, an account of each of the four hundred 'British Birds.' I must content myself, therefore, with a general description which, though far from complete, may yet be interesting and serviceable to the young beginner.

An *ambitious* collector should really possess a work to which he can refer for detailed descriptions of all the British species, and in which he will find not only descriptions of the birds themselves, but particulars concerning their habits, their haunts, and the nature of their nests and eggs. Perhaps, by way of a start, he could not do better than study Stanley's 'History of Birds;' and then, if his ambition soars still higher, and his pocket runs deep, he may go in for the more comprehensive productions of our great authorities.

We can boast of one hundred and twenty-six species of birds that are wholly our own, remaining as they do with us throughout the year, and rearing up their broods in our midst. These we shall speak of as '*resident*.' Then there are about forty others that visit us in the summer, some appearing much earlier than others. These '*summer visitors*' breed in our country, but depart to the more genial climes of the south before bleak winter weather sets in.

Happy birds they must be. A broad expanse of water is no barrier to them, their powerful and enduring flight enabling them to surmount all the obstacles that hem in so many other creatures. Their life is one perpetual summer, and the pangs of hunger quite beyond their experience. They belong chiefly to the *perchers*—a group of birds that includes the majority of our brilliant songsters. Again, there are those which delight more or less in winter blasts and snows—birds that spend their summer in the north, but visit us during the winter, when the cold of higher latitudes is so extreme that the snow-clad wastes and frozen waters no longer yield them their natural food. These '*winter visitors*' are chiefly *waders* and *swimmers*, and obtain their sustenance from waters, fresh and salt; but include also a few of the perchers. Most of them leave us again on the approach of summer, but occasionally remain within our shores throughout the year, supplying us with broods of true Britishers. Lastly, we include in our list of birds a large number of '*occasional visitors*,' nearly two hundred in number, that hail from various parts of Europe, Asia, Africa, and America.

The following table will show at a glance how we make up the total of the so-called British birds:

Resident species	126
Summer visitors	40
Winter visitors	60
Occasional visitors . . about	180
Total, about	406

Of these only about two hundred have been known to *breed* in the British Isles.

Birds of Prey

The British birds of this order may be known at once by the powerful claws by which they seize and carry their prey, and also by the strong hooked beaks used in tearing the flesh from their victims' bones. Their senses are very acute, especially the power of vision, enabling them to single out their anticipated captives at great distances.

We find with birds of prey, as with carnivorous mammals, that the digestive organs are less complicated in structure than in the vegetable feeders. They have no crop, and their gizzards are weaker and smaller in proportion to their size.

The Eagles and Falcons are not likely to come in the way of young collectors, so we shall have but little to say of them. The rude piles of sticks that form their nests are laid on the ledges of

Fig. 364.—The Golden Eagle.

Fig. 365.—The Falcon.

precipitous rocks, so difficult of access that I fear none of my readers are ever likely to meddle with their eggs; and the high price charged by the dealers for some of these treasures is quite sufficient to show that the robbing of such nests is by no means a childish sport.

The Sparrow-hawk and Kestrel are not by any means uncommon; but the Kite, once plentiful in our country, is now comparatively rare. Sometimes we see one of these birds poised motionless in the air, or wheeling round and round in wide circles as it surveys the distant ground. Suddenly it darts downward like a falling stone; and, seizing a poor unfortunate victim in its powerful talons, makes off to its retreat.

Birds are generally cheerful creatures, delighting in the brightest sunshine; but the round and flat-faced Owls, with eyes directed forwards, like our own, are lovers of the dark and silent night. The

Owl is a veritable winged cat. Waking at sunset, it starts out to its hunting grounds in barns, outhouses, hedges, and meadows. Here it sits silently, its big bright eyes steadily scanning the neighbour-

FIG. 366. THE SPARROW-HAWK.

FIG. 367.—THE KESTREL.

hood. At last it spies a mouse or other small animal: and with stealthy and silent movement (for even its flight is noiseless) pounces on its victim, and bears it off to its hungry brood.

Nocturnal animals seldom seem to be favourites with us, and all manner of superstitious fears have been associated with them.

FIG. 368.—THE MERLIN.

FIG. 369.—THE HONEY BUZZARD.

FIG. 370. THE BARN OWL.

FIG. 371.—HEAD OF THE LONG-EARED OWL.

The mournful midnight cries of the Owl have still further intensified the popular dislike to this bird.

Our Perching Birds

Most of these birds are of small size. Their toes are long and slender and well adapted for grasping the branches and twigs of trees. You will observe that one of the toes is directed backwards, thus serving the purpose of a thumb. All our best songsters belong to this group, though some of the perchers, such as the Rooks and the Crows, which are, by the way, the largest species, have voices that are by no means musical. It is among the birds of this order, too, that we meet with those nests, the architecture of which arouses our wonder and admiration.

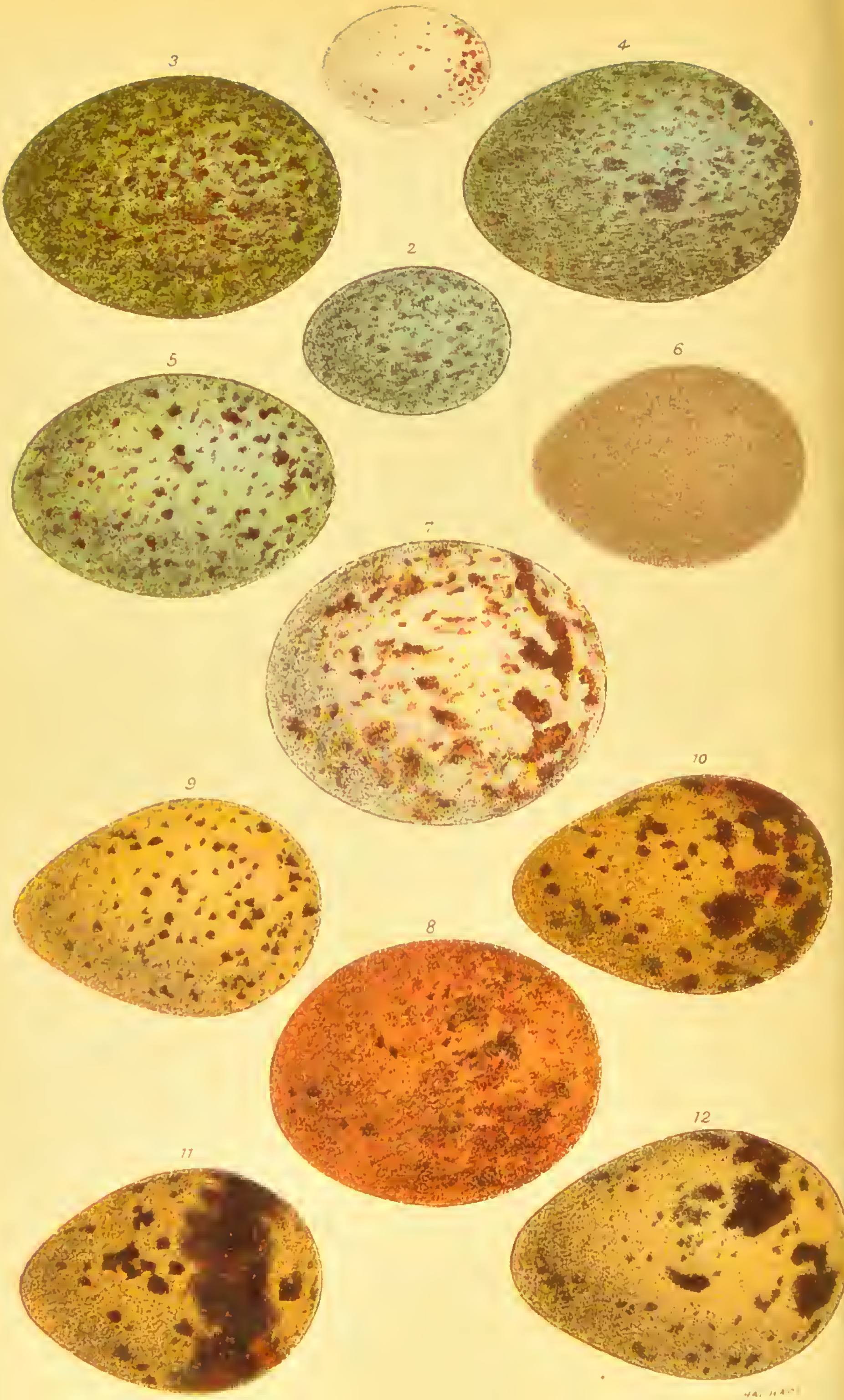
FIG. 372.—THE SHRIKE.

But there is a considerable difference in the building powers of the perchers; for in some cases the nest is merely a rude collection of sticks or stubble, or a scanty lining of grass or other substance in a hollow in the ground.

FIG. 373.—THE ROOK.

And there are some that make not the slightest attempt at building, but simply deposit their eggs in a natural hollow, perhaps just slightly modified to suit their purpose.

Plate X



The remarkable uniformity exhibited by the nests of certain species is really wonderful. Examine, for instance, about half a dozen of the pretty nests of the Hedge Sparrow (*Accentor*), and you

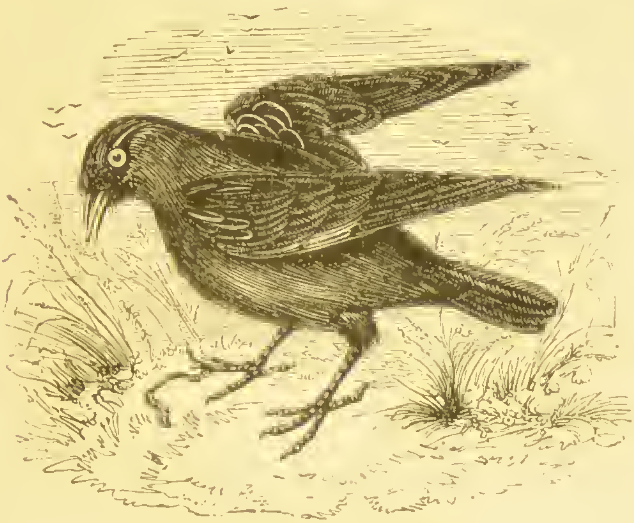


Fig. 374. The Jackdaw.

will be surprised at the similarity both in the form and also in the nature of the materials selected. But there are others whose nurseries vary greatly according to the nature of the site chosen and the materials at hand during the time of building.

The Missel Thrush treats us to a little variety in this way; for, instead of strictly limiting itself to a certain fixed routine, it will collect at random almost anything that comes in its way; and it is not uncommon to find bits of rag, wool, ribbon, and other productions of human art woven into its nest.

Fig. 375.—The Nuthatch.

Some birds are very capricious in the selection of a spot in which to build, but perhaps none so much so as our familiar little Redbreast. It usually chooses holes in banks and decaying trees; but it has been known to take advantage of an open window to erect its nursery on library shelves, or in churches and other buildings.

Fig. 376.—The Woodpecker.

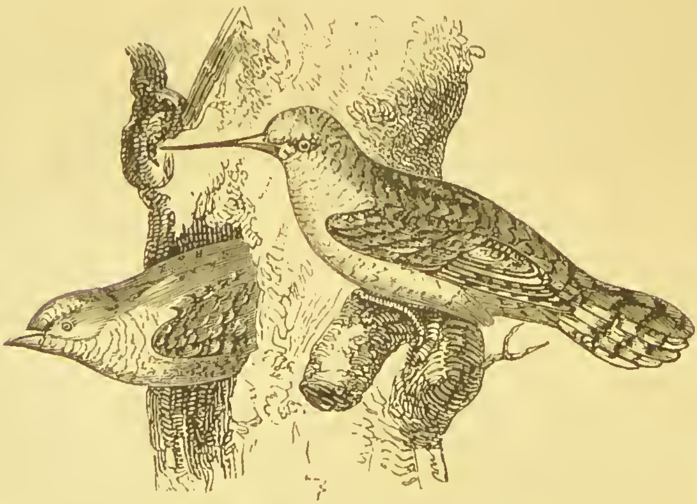


Fig. 377.—The Wryneck.

Two of the Warblers—namely, the Wood Warbler and the Willow Warbler—construct their nests on banks, building them in the form of a dome with an opening at the side; but one of the most wonderful nests of this description is that of the familiar Golden-crested

FIG. 378.—THE KINGFISHER.

Wren. It is suspended from the branch of a fir, yew, or holly tree; and is a hollow ball made of fragments of mosses and lichens, held together by a collection of spiders' webs. It contains about half a dozen of the tiniest of all British birds' eggs.

The Common Wren is another dome builder, but the nest is

generally placed on the ground, or in the lower part of a very thick bush. Sometimes it will select a situation that is well protected above by projecting turf or a log, and in such case will often dispense with the construction of a dome as unnecessary.


FIG. 379.—THE WREN.

One of the most beautiful of nests is that of the Long-tailed Tit. It is oval in shape, and usually lies in the fork of a bush or small tree. It consists of wool, moss, and lichens, all bound together with spiders' webs, and often including a number of spiders' nests woven in with the other materials. The exterior is skilfully covered with lichens, giving it a very pretty appearance, and the interior, which is approached by a hole in the side, is nicely lined with a liberal supply of downy feathers. The eggs, eight or nine in number, are of a very delicate pinkish tint, due to the colour of the interior showing itself through the pure white and semi-transparent shell. When the eggs are blown this delicacy of colour is of course lost; but some collectors restore the natural hue by introducing a pink composition into the emptied shell.

The Blue Tit is remarkable for the strange sites sometimes chosen for its nest. Old pumps have often been selected, and one case has been given of a pair who would not forsake their young


FIG. 380.—THE GREAT TIT.


FIG. 381.—THE LARK.

when the working of the pump had been renewed after a period of rest, even though the hen bird had lost her tail through the friction of the handle.

The Great Tit usually selects a hole in a tree or bank, and

constructs its nest principally of feathers; but, like its blue cousin, it sometimes selects a peculiar site. In the South Kensington Natural History Museum you may see a Great Tit's nest that still lies in the country letter box in which it was constructed.


Fig. 382.—The Goldfinch.

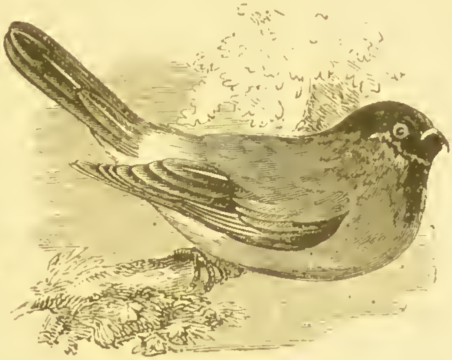


Fig. 383.—The Bullfinch.

The nest of the Skylark shows no superior skill, but is usually well concealed among grass in a slight hollow in the ground. In this position, though not easily found as a rule, it is always in danger of being trodden under foot by cattle.


Fig. 384.—The Linnet.


Fig. 385.—The Cuckoo.

The Chaffinch is remarkable for the wonderful architecture of its nest. The main structure is usually composed of moss, lichens, grass, and other materials, all closely woven together, and is lined with wool, hair, and feathers. The outside is generally very neatly covered with lichens, often rendering it so much like the branches

of the tree on which it is supported that detection is difficult indeed. It is generally placed in the fork of a tree, or hidden in a thick shrub.

During your bird-nesting career you will meet with many nests which, like that of the Chaffinch, are rendered inconspicuous by a

Fig. 386.—The Nightingale.

protective colouring which closely imitates the natural surroundings. Others, like those of rooks and crows, are fully exposed to view, the only protection from danger being the difficulty of access. But, in most cases, the perching birds seek to insure the safety of their broods

by selecting a spot well concealed among the surrounding foliage, either on the ground or in a thick bush. Few of these display more artfulness in this respect than the cherished Nightingale—the 'King of Songsters.' This bird is, unfortunately, not very common. It is only during the summer that we are favoured with its presence; and even then it is restricted to the eastern, midland, and south-eastern counties of England. It seems to cross the narrowest part of the Channel, and then work its way northwards. For years, while residing in the south-west, I never heard its charming notes. It is certainly remarkable that this lover of warm climates should neglect the mildest part of our country. But it does not seem to

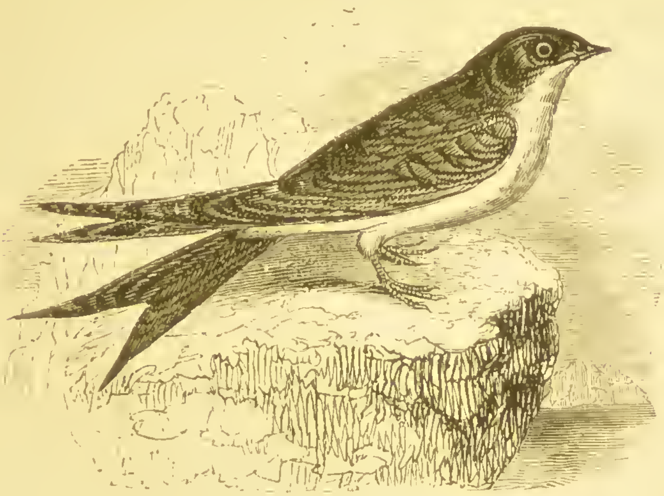


Fig. 387.—The Swallow.

stray far after its arrival on our shores. Its voice is seldom heard in the north of England, and it is only in the coppices of the south-east that the Nightingale abounds. Its nest is very difficult to find, being generally well concealed on or near the ground under thick bushes, or, occasionally, in the stump of an old tree. It sings more or less throughout the day, but it is during the twilight hour, while most other songsters are at rest, that the sweet tune of the Nightingale is so plainly heard.

Unique among nests are those of Swallows and Martins.

The Swallow builds in dark holes of buildings, often selecting for the purpose a chimney that is not at the time performing its usual function, or a tower, or even the shaft of a deserted mine. Its nest

is open, built of mud, and lined with feathers. This busy bird is seldom *seen* at rest. When not engaged in domestic affairs it is either resting in some secluded spot, or it is catching insects on the wing, generally in a sheltered place near a marsh or stream. It may even be seen feeding its young while flying rapidly.

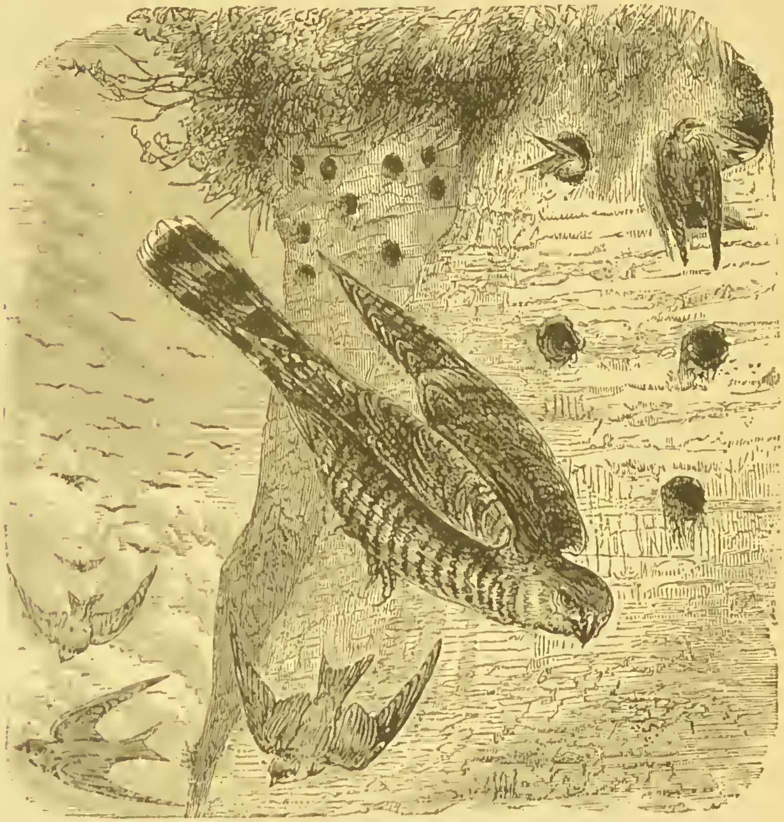


Fig. 388.—The Sand Martin and the Hawk.

The Sand Martin is a burrowing bird. It builds its nest in excavations which it makes in sand banks.

Rasores—Scraping Birds

This order includes two well-defined groups of birds, the first containing Doves and Pigeons, and the second some of our most familiar Game Birds.

Doves and Pigeons, although generally classed with the Scraping Birds, do *not* scratch into the ground for their food after the manner of our domestic fowls and their wild allies, but are grouped with them on account of other features that are considered sufficient to prove their close relationship. They are almost exclusively vegetable feeders, provided with a very large crop, and a strong gizzard. The manner in which these birds feed their young is a marked contrast to that of the perchers. All who have interested themselves in the breeding of cage birds must be familiar with the little group of nestlings during their moments of expectancy. Their necks are stretched to the utmost, and their broad bills gape so widely as almost entirely to hide the rest of the head. Then the parent, whose timely arrival

Fig. 389.—The Stock Dove.

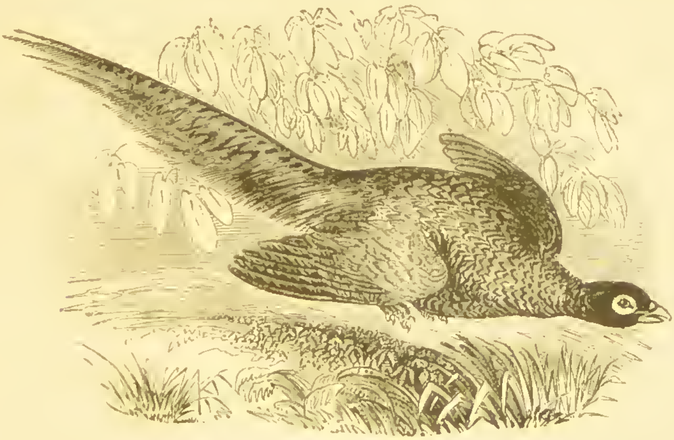


Fig. 390.—The Pheasant.

is the cause of the general commotion, puts a morsel into each mouth, sometimes almost thrusting it down the young one's throat. But with Pigeons and Game Birds the mode of procedure is very different.

Here it is the parent that exhibits the open mouth, leaving the young to take the food from her bill as best they can. The perch-

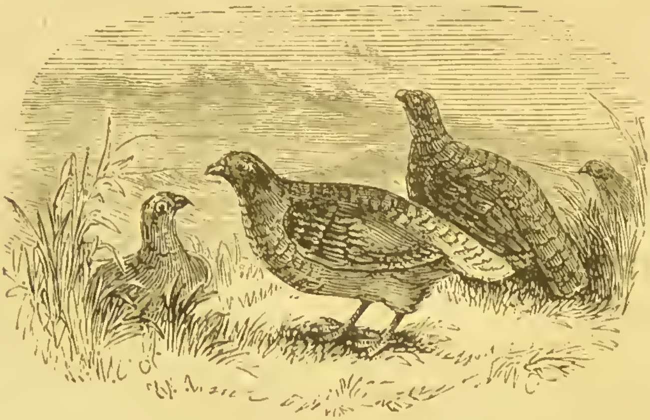


FIG. 391.—THE PARTRIDGE.

ing bird *gives* food to her young, but the Scraper simply *allows* them to help themselves from the supply she brings.

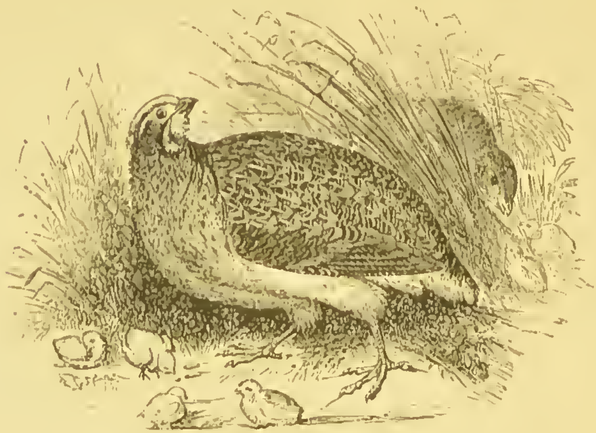


FIG. 392. THE QUAIL.

It will be seen from our table of birds that the 'Scratchers' generally build on the ground or in low bushes. Many of them really *build* no nest at all, but simply collect together a few sticks or straws, with which they line a hollow in the soil.

Wading Birds—Grallatores

The birds of this division are frequenters of marshes and sandy shores, and are particularly adapted for wading in the water and

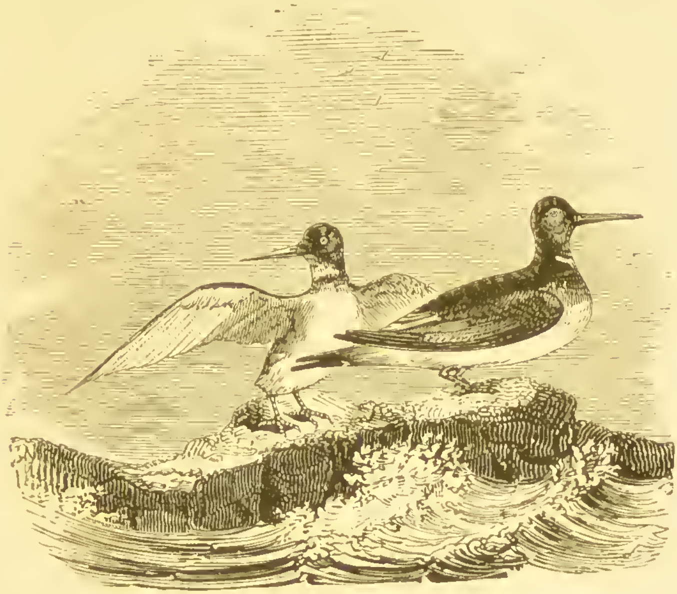


FIG. 393.—THE OYSTER-CATCHER.

mud, from which they derive the worms, molluscs, and fishes that constitute their food. Their legs are long and slender, and free from feathers, except close to the body, and the hind toes are very short. The neck and bill are also long. Thus the bird can wade in water or mud and secure its food without soiling its feathers. Those of the waders that live on fish have the longest legs, and with these, as with all the others, the length of the neck, head, and bill together is always proportionate to the length of the leg.

FIG. 394.—THE HERON.

All the waders have a greater or less development of membrane

between the toes, thus showing a relationship to the swimmers, and some of them are decidedly aquatic in their habits and swim well. As a rule the waders are gifted with considerable powers of flight, and many of them migrate between countries separated by enormous distances.

Many of these birds exhibit great variation in their plumage at different seasons of the year. Thus, the Grey Plover, one of our

Fig. 395.—The Lapwing.

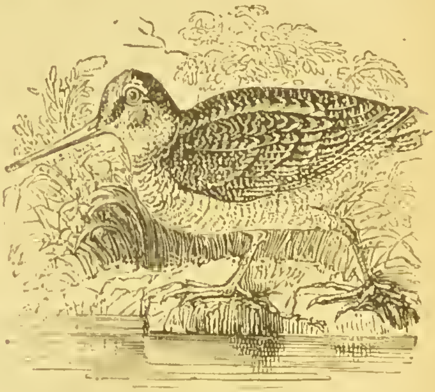


Fig. 396.—The Snipe.

winter visitors, is whitish on the under surface during winter, but black in summer. And, generally, the winter plumage is lighter in colour than that of summer.

Those in search of waders or their nests must themselves be prepared to wade in marshes and bogs, and to ramble along the loneliest parts of our coasts.

Swimming Birds

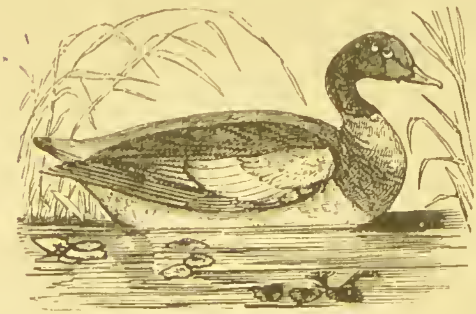


Fig. 397. The Sheldrake.

This order includes all those that are specially adapted for aquatic life. They have webs between the toes for swimming; their legs are short and powerful, and their broad bodies enable them to float well. Some of the swimmers are very large birds, and many of them are brilliantly decorated.

A large number inhabit our lakes and marshes, especially the

Broads of Norfolk, but are being gradually driven from these haunts as the land is reclaimed for agricultural purposes. By far the greater number, however, are inhabitants of our coasts, and

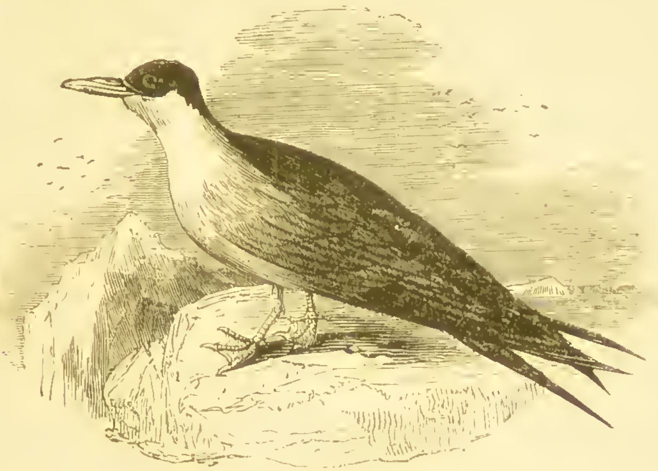


Fig. 398.—The Tern, or Sea Swallow.

subsist either on fishes caught in the sea, or on the refuse of the shore. The Common Gull is one of the coast dwellers, and is

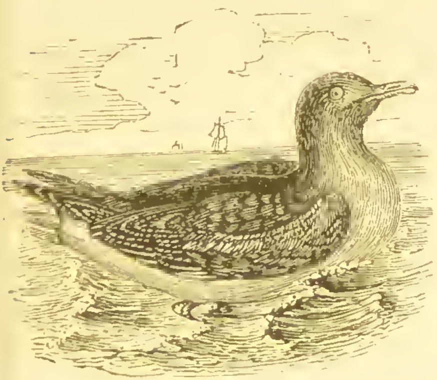


Fig. 399.—The Black-backed Gull.

Fig. 400.—The White Gull.

certainly a most useful scavenger, for it will devour almost any kind of decomposing matter that may happen to be washed up by the waves.

One of the most remarkable features of this group is the strange diversity in the number of eggs laid by the different members.

Thus, the Ducks generally lay a dozen or more before they commence to sit, while the Gulls lay only three or four, and the Guillemot, Puffin, and Razorbill only one.

The swimmers are no architects. Many of them make no nest of any kind, and the others do no more than collect together a little stubble, and deposit it on the bare rock, or on the beach, or in a hollow of the ground.

I can quite understand that some of my young readers who are anxious to 'do' the British Birds thoroughly may be somewhat dissatisfied with the meagre account given here, but I have attempted to amend matters a little by offering what I hope will prove a very useful table to the beginner. The first and second columns contain respectively the common and scientific names. In the third are letters which distinguish the resident species and the summer and winter visitors. The table includes all the resident birds (R) and summer visitors (SV) whose nests are likely to be met with, and also the commonest of the winter visitors (WV) that have been known to breed in the British Isles, excluding a few that are very local in their distribution, or whose nests are made in spots very difficult of access. In the fourth column will be found the usual situation of the nest. The next column contains the names of the materials of which the nests are usually constructed; but I must here remind the reader that he must be prepared to meet with considerable variations, for not only do nests of the same

Fig. 401.—The Grebe.

Fig. 402.—The Guillemot.

Fig. 403.—The Petrel.

species vary according to the nature of the materials at hand in different localities, but some birds are so capricious in the selection of their building materials that nests in the same district may at times exhibit interesting peculiarities. The sixth column contains a brief description of the eggs, the ground colour being the first mentioned, and followed by the tint of the markings, if any. The last column shows the average number of eggs in the clutch; and here, again, great variations will often be met with.

LIST OF COMMON BRITISH BIRDS

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
	Order I. Raptores—Birds of Prey					
Merlin	*Falco Æsalon*	R	On ground, chiefly in North	Twigs and grass	Reddish brown, two shades. Mottled	5
Kestrel	*F. Tinnunculus*	R	On tree or rock	Twigs and grass	Whitish. Dark red blotches	5
Sparrow-hawk	*Accipiter Nisus*	R	On high tree or cliff	Twigs and grass	White. Red and brown blotches and spots	5
Common Buzzard	*Buteo Vulgaris*	R	Tree or cliff	Sticks	Whitish. Brown streaks and spots	2
Marsh Harrier	*Circus Æruginosus*	R	On ground, generally near water	Sticks, sedges, grass	Bluish white	4
Tawny Owl	*Syrnium Aluco*	R	In old tree	Chips of wood, disgorged bones and fur	White and rounded	5
Barn Owl	*Aluco Flammeus*	R	Barn or ruins	Sticks, hay and straw	White	
	Order II. Insessores—Perchers					
Red-backed Shrike	*Lanius Collurio*	SV	Hedge or bush	Twigs, roots, grass, moss, hair, &c.	Whitish. Pale brown and grey spots	5
Spotted Fly-catcher	*Muscicapa Grisola*	SV	Hollow tree or hole in wall	Moss, straw, hair, feathers	Whitish. Red and brown spots	5
Pied Flycatcher	*M. Atricapilla*	SV	Hollow in tree or wall, chiefly in N. England	Roots, leaves, grass, hair	Pale blue	5

Dipper	*Cinclus Aquaticus*	R	Close to water	Moss, leaves	White	5
Song Thrush . .	*Turdus Musicus*	R	Thick bush	Moss, bents, twigs, cow dung	Bluish green. Black spots	5
Missel Thrush .	*T. Viscivorus*	R	Tree or bush	Very varied. Usually sticks, roots and mud	Pale green. Brown spots	4
Blackbird . . .	*T. Merula*	R	Thick bush	Sticks, grass, mud	Pale green. Reddish brown spots	5
Ring Ouzel. . .	*T. Torquatus*	SV	On or near ground	Twigs, grass, mud	Greenish blue. Reddish brown and grey spots	5
Hedge Accentor .	*Accentor Modularis*	R	Hedges	Grasses, moss, horsehair	Greenish blue	5
Robin	*Erithacus Rubecula*	R	Hedge, tree stump, wall	Moss, feathers, horsehair, wool	White. Reddish spots	5
Nightingale . .	*Daulias Luscinia*	SV	On or near ground	Grass and leaves	Dark olive brown	5
Redstart	*Ruticilla Phœnicurus*	SV	Hollow tree or wall	Moss, feathers, &c.	Pale bluish green	6
Stonechat . . .	*Pratincola Rubicola*	SV	On ground or in furze	Moss, feathers, &c.	Pale blue. Reddish brown dots	5
Whinchat . . .	*P. Rubetra*	SV	On or near ground	Moss, grass, wool	Greenish blue. Brown dots	6
Wheatear . . .	*Saxicola Œnanthe*	SV	Walls and rocks. Rabbit burrows	Grass, moss, wool	Pale greenish blue	5
Reed Warbler .	*Acrocephalus Streperus*	SV	Suspended on reed stems	Reed blades, grasses	White. Brown and olive green spots. Variable	5
Sedge Warbler .	*A. Schœnohænus*	SV	Low bush or on ground	Grass, moss, hair, wool, &c.	Greyish. Dark, greenish or brownish mottlings	5
Dartford Warbler	*Sylvia Undatus*	R	Fork of furze bush, Southern counties	Stems and furze	Light green. Speckled brown and grey	5

LIST OF COMMON BRITISH BIRDS—*cont.*

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
	Order II. Insessores—Perchers—*cont.*					
Whitethroat . .	*S. Rufa*	SV	Among nettles and brambles	Grass, cobwebs, horsehair, down	Greenish white. Thickly speckled with olive green and dull red	5
Lesser White-throat	*S. Curruca*	SV	In bush	Grass, roots, horsehair	White. Brown and grey spots	5
Garden Warbler .	*S. Hortensis*	SV	Low bush	Grass, roots, wool, hair	Greenish white. Spotted with olive brown	5
Blackcap . . .	*S. Atricapilla*	SV	Low bush or hedge	Grass, roots, hair	Greenish white. Brown and grey mottlings. Variable	5
Wood Warbler .	*Phylloseopus Sibilatrix*	SV	On ground in woods	Grass, leaves, moss. Domed	White. Thickly speckled with purple brown	6
Willow Warbler .	*P. Trochilus*	SV	On bank	Grass, moss, feathers. Domed	White. Reddish brown spots	7
Chiffchaff . .	*P. Collybita*	SV	Ground	Grass, leaves, moss. Domed	White. Purple brown dots	6
Golden-crested Wren	*Regulus Cristatus*	R	Between boughs of firs	Moss, lichens, feathers. Globular, open at top	Cream colour. Almost globular	7
Common Wren .	*Troglodytes Parvulus*	R	Bank or bush	Ferns, moss, &c. Generally domed	White. Red and brown spots at large end	6

Tree Creeper	*Certhia Familiaris*	R	Hollow tree	Moss, twigs, feathers	White. Pale brown spots	6
Nut-hatch	*Sitta Cæsia*	R	Hollow tree	Moss, leaves	White. Brown and purplish red spots	6
Great Tit	*Parus Major*	R	Hollow tree	Moss, leaves, hair, feathers	White. Reddish brown spots	9
Blue Tit	*P. Cæruleus*	R	Hole in bank, tree, or wall	Moss, grass, wool, feathers	Reddish white. Light red spots	7
Coal Tit	*P. Ater*	R	Hole in bank	Moss, fur, or feathers	White. Reddish brown spots	6
Marsh Tit	*P. Palustris*	R	Hole in bank or tree	Moss, fur, or down	White. Red dots	5
Crested Tit	*P. Cristatus*	R	Hole in tree. Scotland.	Moss, feathers	White. Reddish brown spots	10
Long-tailed Tit	*Acredula Caudata*	R	Fork of tree, or in thick bush	Moss, wool, spiders' web, lichens, feathers. Domed. Hole near top	Pinkish. White when empty. Sometimes small red spots	10
Bearded Tit	*Panurus Biarmicus*	R	On tuft of grass or among rushes	Leaves, reeds, grass	White. Brown wavy lines and specks	6
Pied Wagtail	*Motacilla Lugubris*	R	Hole in rock, bank, or hedge	Moss, leaves, grass, roots, hair. Variable	White. Brown and grey spots	6
Grey Wagtail	*M. Sulphurea*	R	Hole in bank. Near water. Chiefly in North	Grass, moss, wool, hair, feathers	White. Dark grey spots	4
Yellow Wagtail	*M. Raii*	SV	On ground or bank	Grass, roots, hair	Yellowish. Olive yellow or brown	5
Tree Pipit (Titlark)	*Anthus Trivialis*	SV	On ground	Grass, roots, hair	Very variable. Dull white. Mottled with warm purple brown	5
Meadow Pipit	*A. Pratensis*	R	On ground	Grass, hair	Grey. Brown and grey spots	5

LIST OF COMMON BRITISH BIRDS—*cont.*

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
	Order II.		INSESSORES—PERCHERS—*cont.*			
Rock Pipit . . .	*A. Obscurus*	R	Under rock or stone. Usually near sea	Grass	Variable. Grey or light brown. Purple brown mottlings	5
Skylark	*Alauda Arvensis*	R	On ground	Grass	Dull white. Thickly speckled dark brown	5
Woodlark . . .	*A. Arborea*	R	Ground	Grass, moss	Whitish. Brown spots	4
Reed Bunting . .	*Emberiza Schœniclus*	R	In tall grass. Marshy spots	Reeds, grass, horsehair	Purple brown. Very dark purple blotches	6
Common Bunting	*E. Miliaria*	R	On bank. often under a bush	Grass, roots, hair	Grey. Purple-black blotches and streaks	5
Yellow Buntiug .	*E. Citrinella*	R	Under thick bush	Grass, hair	Pale purple brown. Dark purple streaks and blotches	5
Chaffinch . . .	*Fringilla Cœlebs*	R	Fork of bush, or in fruit tree	Moss, grass, lichens, wool, hair, feathers	Purple brown. Dark purple-brown spots and streaks	5
Tree Sparrow . .	*Passer Montanus*	R	Hole in wall, or on tree top	Grass, horsehair, feathers	Dark grey. Thickly spotted brown	5
House Sparrow .	*P. Domesticus*	R	On houses	Grass, straw, feathers	Greyish or bluish. Spotted brown and dark grey	5
Hawfinch . . .	*Coccothraustes Vulgaris*	R	Top of bush	Sticks, moss, lichens, feathers	Bluish green. Sepia and brown spots and lines	5

Greenfinch	*C. Chloris*	R	Thick bush or hedge	Grass, moss, wool, hair	White. Reddish brown and purplish grey spots	5
Goldfinch	*Carduelis Elegans*	R	Fir, elm, fruit tree or bush	Grass, moss, down, feathers	Bluish white. Purple and brown spots	5
Lesser Redpole	*Linota Linaria*	R	Gorse bush	Grass, feathers	Bluish white. Speckled at large end with reddish brown	5
Linnet	*L. Cannabina*	R	Bush or hedge	Grass, roots, moss, hair, feathers	Pale bluish grey. Speckled with red	5
Bullfinch	*Pyrrhula Europæa*	R	Bush or hedge	Sticks, grass, roots, feathers	Pale blue. Purple and red spots and streaks	5
Starling	*Sturnus Vulgaris*	R	Holes in walls and trees	Straw, grass, roots, feathers	Pale greenish blue	5
Carrion Crow	*Corvus Corone*	R	Trees	Sticks, moss, straw, hair, wool	Greenish. Brown, grey and olive spots	5
Rook	*C. Frugilegus*	R	Trees	Sticks, clay, grass, roots	Variable. Greenish blue. Brown and olive green blotches	4
Jackdaw	*C. Monedula*	R	Holes in trees, walls, and rocks	Sticks, straw, wool, feathers	Pale blue. Grey and brown spots	5
Magpie	*Pica Caudata*	R	Tree or bush	Sticks, clay, mud, roots. Domed with thorny sticks	Dull green. Spotted with grey and olive brown	5
Jay	*Garrulus Glandarius*	R	Top of thick bush or in tree	Sticks, roots, grass	Greenish blue. Pale brown spots	5
Green Woodpecker	*Picus Viridis*	R	Hole in tree	Builds no nest	Glossy white	5
Great Spotted Woodpecker	*P. Major*	R	Hole in tree	Builds no nest	Glossy white	5

LIST OF COMMON BRITISH BIRDS—*cont.*

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
	Order II. INSESSORES—PERCHERS—*cont.*					
Wryneck	*Junx Torquilla*	SV	Hole in tree. Chiefly south-east of England	Builds no nest	Pure white. Glossy	9
Cuckoo	*Cuculus Canorus*	SV	No nest	Lays in nests of accentor, titlark, wagtail and others	Dull white. Brownish green spots	1
Kingfisher	*Alcedo Ispida*	R	Hole in bank of stream	Fish bones	Cream white. Very rounded and glossy	5
Swallow	*Hirundo Rustica*	SV	Dark holes in houses and towers	Mud, feathers	White. Reddish brown spots	5
Martin	*H. Urbica*	SV	Under eaves of houses	Mud	Pure white	5
Sand Martin	*H. Riparia*	SV	Holes in sandy cliffs	A few straws and feathers	Pure white	5
Swift	*Cypselus Apus*	SV	Holes in walls and in outhouses	Feathers, straw	Pure white. Long and narrow	3
Nightjar	*Caprimulgus Europæus*	SV	On ground, under bush or tree	Ferns and leaves	Greenish white. Brown spots and stripes	2
	Order III. RASORES—SCRATCHERS					
Ring Dove	*Columba Palumbus*	R	On bush or tree in wood	Sticks	White	2
Stock Dove	*C. Œnas*	R	Holes in trees or ground, or among branches	Sticks and grass	White	2

Rock Dove	*C. Livia*	R	Rocks and cliffs	Twigs and grass	White	2
Turtle Dove	*Turtur Auritus*	SV	Low bushes	Small sticks	Pinkish white	2
Pheasant	*Phasianus Colchicus*	R	In ground	Few leaves and grass blades only	Olive brown	12
Black Grouse	*Tetrao Tetrix*	R	On ground. In moors	Twigs and grass	Yellowish brown. Orange-red spots	9
Red Grouse	*Lagopus Scoticus*	R	Under heather	Twigs and straw	Ashy red. Thickly covered with dark reddish brown blotches	6
Ptarmigan	*L. Mutus*	R	In sheltered spot on ground	Twigs and grass	Reddish yellow speckled with dark reddish brown	7
Partridge	*Perdix Cinerea*	R	Hollow in ground	Few blades of grass and feathers	Olive brown	12
Red-legged Partridge	*P. Rufa*	R	Hollow in bank	Grass and feathers	Yellowish white. Red brown and ash spots	7
			Order IV. GRALLATORES—WADERS			
Great Plover	*Ædicnemus Crepitans*	SV	Among stones on moors	Builds no nest	Light brown. Blue and brown spots and streaks	2
Golden Plover	*Charadrius Pluvialis*	R	On ground, moors	Builds no nest	Yellowish. Very dark brown blotches	4
Lapwing	*Vanellus Cristatus*	R	Moors and marshes. On ground	A few stems only	Yellowish brown. Dark brown blotches	4
Dotterel	*Eudromias Morinellus*	SV	On moors	A few lichens	Grey. Brown and dark grey blotches	3
Ringed Plover	*Ægialitis Hiaticula*	SV	Hollow in sand or shingle of sea beach	No nest	Variable. Pale grey or green. Reddish brown and black spots	4

LIST OF COMMON BRITISH BIRDS—*cont.*

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
Order IV. GRALLATORES—WADERS—*cont.*						
Oyster Catcher	*Hæmatopus Ostralegus*	R	On beach	Sea-weed and grass	Yellowish. Spotted bronze and dark brown	4
Greenshank	*Totanus Glottis*	R	On ground. North Scotland	Grass and stems	Light olive brown. Spotted dark brown and purple grey	4
Redshank	*T. Calidris*	WV	Bogs and marshes	Grass	Reddish or greenish white. Blotched dark brown	4
Green Sandpiper	*T. Ochropus*	R	Bogs and marshes	Grass	Light red or greenish. Spotted grey brown	4
Ruff	*Machetes Pugnax*	SV	Among sedges	Grass	Olive brown. Spotted grey brown. Variable	3
Common Sandpiper	*Actilis Hypoleucos*	SV	Marshes	Leaves, grass, moss	Reddish or yellowish white. Spotted dark brown and grey	4
Woodcock	*Scolopax Rusticola*	WV	On ground in woods	Dry leaves and ferns	Whitish. Spotted yellow brown and grey	4
Common Snipe	*G. Media*	R	Hole in ground or bank	Grass	Olive green. Blotched and speckled brown	4
Heron	*Ardea Cinerea*	R	Top of tree or cliff	Twigs, grass, feathers	Pale bluish green	4
Water Rail	*Rallus Aquaticus*	R	Marshy districts. On ground	Sedges and flags	Cream. Speckled reddish brown and grey	7
Land Rail	*Crex Pratensis*	SV	Cornfields and meadows	Straw	Yellow brown. Spotted reddish brown	9

Spotted Crake	*Artygometra Porzana*	SV	Among rushes. Floating on water	Sedges	Reddish white. Speckled reddish brown	7
Moorhen	*Gallinula Chloropus*	R	Among flags	Reeds and sedges, feathers	Light brown. Spotted light reddish brown	8
Coot	*Fulica Atra*	R	Among reeds and rushes	Withered weeds	Smoky white. Spotted all over brownish black	
Order V. NATATORES—SWIMMERS						
Sheldrake	*Tadorna Vulpanser*	R	In rabbit burrows, near coast	Grass and down	Greenish white	10
Wild Duck	*Anas Boschas*	R	Under bush, near water	Grass, weeds, and down	Light green	12
Teal	*Querquedula Crecca*	R	Under bush, near water	Withered weeds and down	Creamy buff	12
Eider Duck	*Somateria Molliosima*	R	On coast. Generally under shelter of bush	Twigs, sea-weeds, and moss. Covered with down	Light green. Glossy	6
Crested Grebe	*Podiceps Cristatus*	R	In ponds among weeds. Nest often floats	Reeds and grass	Greenish white	5
Little Grebe	*P. Minor*	R	Beside ponds. On heap of vegetable matter	Various weeds	Dull white. Long and pointed	5
Puffin	*Fratercula Arctica*	R	On steep cliffs	Builds no nest. Hole in ground	White. Sometimes spotted pale grey	1
Razorbill	*Alca Torda*	R	On steep cliffs	Builds no nest	Variable. Cream white. Blotched dark brown	1

LIST OF COMMON BRITISH BIRDS—*cont.*

Common Name	Scientific Name		Situation of Nest	Materials of Nest	Description of Egg	No.
Order V. Natatores—Swimmers—cont.						
Guillemot . . .	*Uria Lacrymans*	R	Rugged cliffs	No nest	Very variable. Very tapering. Greenish blue. Blotched dark brown or black	1
Cormorant . . .	*Phalacrocorax Carbo*	R	Steep cliffs	Sticks and sea-weed	Greenish white. Chalky surface	4
Shag	*P. Cristatus*	R	Steep cliffs	Sea-weeds aud grass	Greeuish white. Chalky surface	4
Gannet . . .	*Sula Bassana*	R	Steep cliffs	Grass and weeds	Bluish white	1
Black Tern . .	*Hydrochelidon Nigra*	R	Marsh Generally near sea	Builds no uest	Olive green. Spotted dark brown	3
Common Tern .	*Sterna Fluviatilis*	R	On shingle	No uest	Yellowish or brownish white. Spotted brown	3
Arctic Tern . .	*S. Macroura*	R	On sandy beach. North Britain	No nest	Very variable. Yellowish white. Spotted dark brown	3
Sandwich Tern .	*S. Cantiaca*	R	On sandy soils	No nest	Stone colour. Spotted deep reddish brown	2
Lesser Tern . .	*S. Minuta*	R	Marshes, banks of streams, or low shores	No nest	Light brown or greenish. Spotted grey and dark brown	3
Black-headed Gull	*Larus Ridibundus*	R	In marshes, near coast	Sedges, reeds, and grass	Variable. Greenish brown. Spotted brown	3

Common Gull .	*L. Canus*	R	In marshes or on rocks near sea	Sea-weeds	Olive brown. Spotted dark brown and grey	3
Herring Gull . .	*L. Argentalus*	R	On rocks	Sea-weeds and grass	Olive brown. Spotted dark brown and grey	3
Lesser Black-backed Gull	*L. Fuscus*	R	On rocks and barren islands	Sea-weeds and grass	Variable. Greenish or brownish. Spotted brown and black	3
Black-backed Gull	*L. Marinus*	R	In marshes	Weeds and grass	Yellowish or greenish. Spotted brown and grey	3
Kittiwake . . .	*Rissa Tridactylus*	R	On rocks near sea	Sea-weed and grass	Greenish or stone colour. Blotched brown. Variable	2
Great Skna . .	*Stercorarius Catarrhactes*	R	High cliffs	Grass and heather	Greenish. Blotched brown	2
Manx Shearwater	*Puffinus Anglorum*	R	Rocky islands	Leaves, moss	Pure white. Nearly round	1
Fulmar . . .	*Fumarus Glacialis*	R	On cliffs	Sea-weed and grass	Pure white	1
Stormy Petrel .	*Procellaria Pelagica*	R	In rabbit burrows on coast	Sea-weed and grass	White	1

CHAPTER VIII

BRITISH MAMMALS

We have now reached the highest of all the divisions of the Animal Kingdom—the class in which we ourselves are included.

The creatures in this group possess several features in common with birds, but they also exhibit many distinguishing characteristics, the most important being the habit of suckling their young, which gives the name to the class—Mammalia or Milk-giving Animals.

Mammals are divided into several orders, the basis of classification being generally the form and arrangement of the teeth, or the nature of the limbs. It will be well, therefore, to spend a little time in examining these organs in a few typical forms.

Let us first study the different forms of teeth; and, as you yourself are a British Mammal, start with your own. A peep in the looking-glass will show that you have three kinds of teeth. Those in the front of the mouth have chisel-like edges, and are adapted for biting only. At the back of each jaw you will see teeth of quite a different character. They are comparatively massive, and their working surfaces are very broad and irregular. These are the millstones by which we grind up our food—the true masticators. Between these two kinds you will see teeth that are more or less conical in form.

Fig. 401. Part of the Upper Jaw (Human), showing the kinds of Teeth.

i, incisor; *c*, canine; *m*, molar.

Now, we shall often have to speak of these three kinds of teeth as we chat about our Mammals, so we will name them. The cutting or biting teeth, which are always situated in front when present at all, are the *incisors*; the grinders are called the *molars*; and the pointed teeth are known as the *canine* or *dog teeth*—not that they

very closely resemble the teeth of Dogs, but because they occupy a position corresponding with that of the long tearing teeth of the Dog and other flesh-eating Mammals.

Now compare your teeth with those of the Cat or Dog, either of which may be taken as representing the Carnivora.

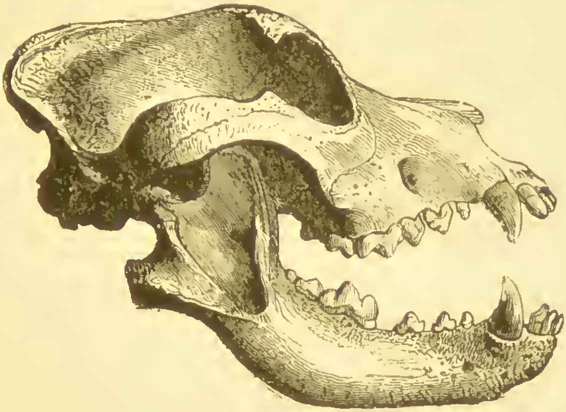


FIG. 405.—SKULL OF A CARNIVOROUS MAMMAL—THE DOG.

Here you observe that the *incisors* are small, and are *not* furnished with chisel edges, so that the creature could not cut up its food as we do. Then, the *canines* are very long, curved, and pointed. These are the instruments used to grip the flesh tight while it is being torn. The *molars*, too, are very different from ours. They are very poor grinders indeed, for they are all more or less pointed. How, then, can the creature *masticate* its food? It does not do so at all. It simply pulls away pieces of flesh sufficiently small to be gulped, and leaves the remainder of the work to be done by the digestive fluids of the stomach and intestines.

FIG. 406.—SKULL OF THE SHEEP.

Now we will glance for a moment at the skull of the Cow or Sheep. Here we find good examples of incisor teeth, but in the lower jaw only. In the front of the upper jaw

there is a pad or cushion of gristle against which the lower incisors press. This arrangement enables the creature to grip the herbage on which it feeds; and it is then torn off, rather than bitten, by a quick movement of the head. The canines, too, are present in the lower jaw only, and, like our own, are not very conspicuous. But look at the broad molars, with their flat grinding surfaces. These are veritable millstones, that effectually crush the vegetable matter to a pulp.

We must notice here a marked difference between carnivorous and herbivorous Mammals as regards the motion of the lower jaw. That of the flesh-eaters is so jointed to the skull that it is capable of an up-and-down movement only—they can *bite* but not masticate. But watch a Cow as she 'chews the cud,' and you will see the jaw swaying from side to side as the molars are brought together, so that the food is thoroughly mashed. You will also observe that you move your lower jaw somewhat in the same way as you masticate your food.

The feet of these harmless creatures are not supplied with claws, but the toes are inclosed in two hoofs, and although the limbs are not powerful, yet most *Ruminants* are fleet-footed; many of them so much so that their carnivorous enemies could never succeed in catching them without resort to stratagem.

Let us take yet another illustration of the great diversity of structure and habit among the *Mammals*. The little Mole is familiar to everybody—too familiar the farmer would say. We shall speak of this interesting little creature again presently, as all we want to do now is to examine its teeth and limbs. With regard to the former, it has the three kinds, but all exceedingly small. None are specially adapted for cutting, tearing, or grinding. Yet all are useful to the Mole; for it lives on worms and grubs, and these small teeth are just the very thing to hold the struggling prey till an opportunity occurs in which to gulp it down.

But one of the most remarkable features of the Mole is its fore limb. This is very strong, and stoutly built, with a well-formed shoulder girdle; and the sole of its foot is turned outward and backward, forming a powerful digger by which it can scoop away the soil and shovel the débris behind it as it proceeds.

These examples will suffice to illustrate the manner in which the classification of the Mammals is carried out, but we have taken types of only a few of the numerous orders into which the group is divided.

The following useful table will give a more extended view of the class; and, at the same time, show how poorly the Mammals are represented in Britain. The list shows only the more prominent orders, and the asterisks mark those of which we have representatives in a wild state, not including, however, such creatures as the Deer, which have been preserved in a semi-wild condition for sporting purposes and for ornament.

CLASSIFICATION OF MAMMALS

Orders	Chief Characters	Examples
1. *Marsupialia* .	Pouched Mammals	Kangaroo. Opossum
2. *Edentata* . .	Toothless Mammals	Anteater. Armadillo
3. *Ungulata* . .	Single-hoofed Mammals	Horse. Rhinoceros. Pig
4. *Ruminantia* .	Cud-chewers	Cow. Sheep. Deer. Camel
*5. *Cetacea* . .	Whale-like Mammals	Whale. Porpoise. Dolphin
*6. *Pinnipedia* .	Fin-footed Mammals	Seal. Walrus
*7. *Carnivora* .	Flesh-eaters	Cat. Dog. Weasel. Pole-cat
*8. *Rodentia* . .	Gnawers	Squirrel. Rat. Rabbit
9. *Proboscidea* .	Trunk-bearers	Elephant
*10. *Insectivora* .	Insect-eaters	Shrew. Mole. Hedgehog
*11. *Cheiroptera* .	Finger-winged Mammals	Bat. Flying Fox
12. *Primates* . .	Highest Mammals	Monkey. Ape. Man

CETACEOUS MAMMALS

The whale-like Mammals are by no means well represented in British seas, and one species only is so well known as to deserve mention here. This one is the Common Porpoise, so often seen in our harbours, especially in stormy weather.

A troop of these creatures affords a very singular and interesting spectacle when watched from a neighbouring cliff or from a passing boat, and they frequently perform their merry gambols so close to observers on land or afloat that their manœuvres are easily observed. Suddenly a huge black mass appears above the surface of the water, and immediately we are startled by a sound resembling a powerful and prolonged sneeze, during which a little fountain of spray is shot a short way into the air. Then follows a kind of

somersault, and the strange creature disappears from view. Then, looking in the direction from which it came, we see many others, all repeating the same strange performance. We now turn again to the leader of the troop, who has by this time made a considerable advance. Again and again it appears above the waves, and at such regular intervals that, by counting the time, we may know when to expect it.

Ask any 'old salt' what these peculiar beings are, and he will tell you with much confidence that 'them 'ere big fishes are porpusses.' But don't venture to ask him whether they are really

Fig. 407.—The Porpoise.

fishes, or he may eye you with such a look of pity for your ignorance that you will feel sadly disconcerted. 'They live in the sea. Is not that sufficient proof?' Such would be the argument of the majority of persons who are acquainted with these creatures, and it would take much to convince them that they are warm-blooded animals, much more nearly related to ourselves than fishes, breathing by lungs instead of gills, and actually nursing their young as the cat does its kittens!

These Porpoises represent the Whales of other seas, but, of course, are very much smaller. They live entirely on small fishes and

molluscs, and may often be seen pursuing a shoal of herrings, of which they are very fond. At one time they were captured in large numbers, not only for the sake of their flesh, which was eaten, but also for the fat stored so abundantly beneath the skin, and for the skin itself, of which a splendid leather is made.

Being a lung-breathing animal, the porpoise must necessarily come to the surface of the water at short intervals to renew its supply of air. The expended air is forcibly expelled through its 'blow-holes,' as the nostrils are termed; and after it has taken a fresh supply and again dived under, the water is prevented from entering the air passages through these openings by folds of the skin that extend over them, acting as valves.

After all, there is not a great deal to be learnt about the porpoise by simply watching it in the water. If we are to know anything of its structure we must examine one that has been removed from its native element. Under these circumstances we can at once point out many features in which it is different from all the fishes. Its thick skin is smooth, and not protected by scales. It has no visible hind limbs, and the fore pair are fin-like, but then they are very different in appearance and structure from the fins of fishes. It is certainly fish-like in form, and, like fishes, has no neck; but its skeleton always contains the seven *vertebræ* or neck bones which characterise the Mammals. The tail is horizontal, consisting of two flat lobes, and is the chief means of locomotion; but, instead of rays with intervening membrane, like the tails of fishes, it is composed of folds of the skin. Its jaws are armed with a great number of simple teeth, not at all large considering the dimensions of the owner.

If Seals were common on our coasts we should undoubtedly regard them with great interest; for not only are their movements and habits very entertaining when watched in their native element, but they are capable of becoming gentle and intelligent domestic pets. But since they are to be observed only on the less accessible parts of our northern shores, we shall pass on at once to the Carnivorous Mammals.

Carnivorous Mammals

It will not be necessary to enter any further into the distinguishing features of the Flesh-eating Mammals, having already pointed out their chief characteristics on page 299.

Fortunately for us, our country is in no wise overrun by voracious quadrupeds. All the larger ones that formerly flourished in the then extensive forests are now extinct or very rare. The Fox is to be found in 'preserves' only, the Badger is rare, and the Otter is to be met with only in the rocky parts of Scotland.

Those who have had the opportunity of witnessing the Otter in its native element must have been struck by its graceful movements.

FIG. 408.—THE OTTER.

Its long and flexible body, and short powerful limbs, enable it to make rapid progress in water at any depth; and its tail, being somewhat compressed, serves the purpose of a rudder. Its food consists of fishes, which, if not caught readily, are chased till quite exhausted.

The female makes her nest of grass and leaves in the bank of a river or lake, but I fear that not many of my readers will ever meet with its litter of four or five young ones.

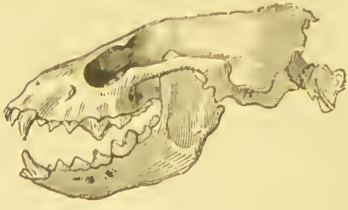


FIG. 409.—SKULL OF THE OTTER.

FIG. 410.—THE WEASEL.

The Weasel, Stoat, and Polecat are to be found in wooded districts, where they make their burrows in sheltered banks. They are very courageous and ferocious, and may be classed among the

pests of the farmyard, for they rob the nests of our domestic fowl, carrying off the young chickens. Yet they are useful creatures; and, perhaps, really do more good than harm, for they kill large

FIG. 411.—THE STOAT.

numbers of rats and mice that would otherwise do great damage to the farmers' crops and stores.

The Weasel is only seven or eight inches long. Like the Squirrel, it is remarkably active in climbing trees and walls. The best way to get a glimpse of these nimble creatures in their haunts is to take up your position in some hiding-place, and there remain perfectly still for some time. It is astonishing what a number of living beings will approach you closely under these circumstances. Those which are by nature very timid will come so close that their every movement may be watched. By means of this stratagem you may also learn the whereabouts of their homes; and then, if you feel inclined, you have the opportunity of searching out their nests. The Weasel and Polecat both make comfortable little nests of grass and leaves, and the former brings up two or three broods of young each year.

FIG. 412.—THE POLECAT.

OUR GNAWING MAMMALS

The Gnawing Mammals or *Rodents* are mostly of very small size, and so many of them are either well known as pets or are easily caught in our homes and fields that the reader will find little difficulty in verifying most of the following particulars.

The order includes Mice, Rats, Squirrels, Rabbits, and Hares.

The name applied to the group at once marks the distinguishing habit of these creatures; and the form and arrangement of their teeth, and also the manner in which they are used, are so interesting that we must have a little to say about them.

Take any one of our little *Rodents* into your hand, and examine the creature's mouth—not hastily, but with as much care as a dentist would scrutinise your own. To do this you must either

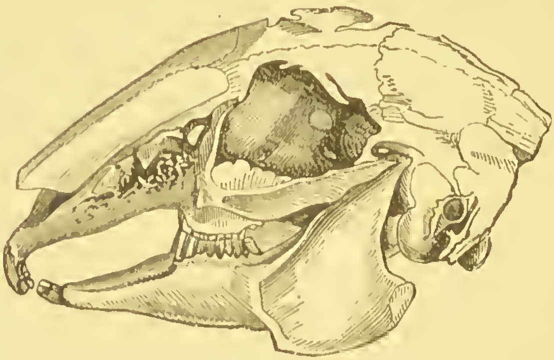


FIG. 413.—SKULL OF THE HARE.

turn it over on its back, or you must lift it on its hind legs, for the mouth is on the *under* side of the head, and for a moment may remind you of the shark, although, of course, the resemblance is not a very striking one.

What a peculiar arrangement of teeth! In the front of each jaw are two very long *incisors*; and if your examinee is a wild *Rodent* which you have only just recently made a captive, it may possibly convince you, in a very forcible manner, that these *incisors* are not only as keen-edged as chisels, but also that they are set in action by rather powerful muscles. Now look beyond these, and you find that the *canines* are wanting; in fact, there is a very long space on each side without any teeth at all. At the back of each jaw, however, are a few rather small *molars*.

But we must look more closely into the front teeth—the gnawers as we may call them; for in these we shall see a peculiar provision that we have not hitherto noticed. The front surfaces of these are very hard and glossy, being covered with a layer of a very durable substance called *enamel*. Now, the exposed surfaces of our teeth, and also those of most Mammals, are entirely covered with this protecting substance, while the remainder is composed chiefly of a softer (but yet very hard) material termed *dentine* or *ivory*. But the front teeth of our *Rodent* are covered with enamel on the front surface only, so that the dentine is quite exposed behind. If now we look at the extremities of the teeth, we see the result of this peculiar arrangement; for here the *dentine* is worn off to a bevel just like the top of a chisel, while the harder *enamel* stands out prominently in front, always presenting a keen edge.

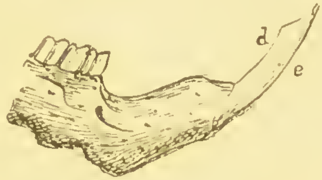


FIG. 414.—THE INCISOR TOOTH OF A RODENT.
e, enamel; *d*, dentine.

The Rodents find plenty of work to do with these gnawers, not only in perforating nutshells, and in reducing various hard substances that form part of their food, but also in biting their way through obstacles as they excavate their burrows and hiding-places. So much work, indeed, do they accomplish, that, if their *incisors* did not grow rapidly, even the enamel would be worn down to the jaw.

Should any one of us lose a tooth, we should hardly regard the loss as a *very* serious matter, even if we knew that another could not be expected to appear in the gap formed. But the loss of an incisor is sufficient cause for great alarm in the case of a Rodent; for the opposite tooth, having now nothing to work against it, continues to grow with but little wear and tear, till at last it either describes a large curve that prevents the creature from closing its mouth, or it actually penetrates the other jaw and locks it firmly. In either case the poor animal cannot use its teeth at all, and eventually dies of starvation. I once came across an old rat that had evidently died through this cause, for one of the incisors of the lower jaw had grown till it projected almost two inches, forming a kind of semicircular tusk.

The feet of Rodents are all constructed on the same general plan, with well-formed fingers or toes, each terminating in a

sharp claw. But some of them use their fore paws very cleverly, both in climbing and in holding their food. Those that use their front limbs much for climbing, such as the Squirrels, have them supported by collar bones like ourselves; but the others do not possess this bone at all, or only in an undeveloped state.

Some spend the winter months in seclusion, and lay in a store of food sufficient to last them through the barren season; while others are true *hibernators*, remaining in a state of slumber throughout the cold months, taking no food during the whole time. But even these hibernating species do provide a store, though unconsciously; for, during the time of plenty, their appetite leads them to devour more food than is necessary for present nutrition; and the excess gives rise to a store of fat that is gradually consumed in their slumbers. But this disappears by the spring time, and they emerge from their retreats in a lean and hungry condition.

It is not an easy matter to catch a Squirrel without some kind of trap; but I succeeded on one occasion by means of a simple stratagem. The creature was on a low bank on the borders of a wood, when first seen; and, when alarmed, rushed up into one of the small and slender oak trees which formed the nearest part of the wood, there being no large trees close by. Then it endeavoured to make straight for the nearest large tree by jumping from bough to bough amongst the young oaks. I followed it up, shaking the trees as it hastened on. This at last caused it to lose its foothold, and it fell to the ground close to my feet. I snapped at it immediately; but before two seconds had passed it had made a forcible appeal for its liberty by causing its incisors to meet in the flesh of my finger. This was repeated so often, that, having nothing in which I could convey it home, I was compelled at last to let it go.

Fig. 415.—The Squirrel.

The Squirrel constructs a nest for its young among the slender boughs of some large tree; but the winter nest in which it hibernates is usually built in the fork of larger branches, and is consequently more easily reached.

A word or two may be added about the Field Mice and the

Fig. 416. The Harvest Mouse and its Nest.

Water Rat. The former are easily captured by those who search diligently among the grass in fields. They are also easily tamed, and become interesting little pets. The Harvest Mouse is the smallest of all our Mammals. Its nest is one of the most wonderful I know. It is a very delicate globular structure, about three inches in diameter, composed of blades of grass beautifully interwoven, and

is usually suspended among grass stems. You should search for these nests at about harvest time in hay and corn fields.

Fig. 417.—The Long-tailed Field Mouse.

The Water Rat is, perhaps, less interesting than the Mouse; but if you do not mind wading in sheltered streams where its

Fig. 418.—The Water Rat.

burrows exist you stand a fair chance of discovering not only its own nest, but also that of the beautiful Kingfisher, for this bird often rears its young in the deserted burrows of the Water Rat.

Insectivorous Mammals

We have a few very interesting little animals belonging to this order. Among them may be mentioned the Shrews, the Hedgehog, and the Mole. These all have pointed teeth, something like those of the *Carnivora*, but very small. They feed principally on worms, grubs, and pupæ.

Fig. 419. The Common Shrew.

The Common Shrew is often called the Shrew Mouse, but the above remarks show that it is no relative of the Mice. The long snout of this and the other Shrews always affords an unmistakable distinguishing mark.

You will have no difficulty in catching the Common Shrew when once you see it, for it is not a very active little creature. Its favourite haunts are sheltered banks; and it often shows a preference for barns, outhouses, and wood stacks. Its brood of about six young are nestled in a little home constructed of grasses and leaves.

There is one remarkable fact concerning Shrews, which, although often mentioned, has never, I believe, been satisfactorily explained. It is that, during the month of August, numbers of them may be

Fig. 420.—The Water Shrew.

seen lying dead on the ground, without any marks of injury on their bodies. It may be that their lives are remarkably uniform in length, and naturally terminate about this time.

If you would like to observe the frolicsome antics of the Water

Shrew, stretch yourself out on the bank of a rather sluggish stream, and there remain quite motionless for a time. Then, if you have been fortunate in the selection of your ground, you will see these little creatures darting and dodging about in the stream, looking almost like living masses of quicksilver. This strange appearance is due to the reflection of light from the numerous air bubbles that become entangled in their closely set fur. Their nests are made in burrows in the banks of the stream, and are often approached from below the water level.

The Hedgehog need hardly be described. Everyone knows its

Fig. 421.—The Hedgehog.

spiny coat. But you cannot say that you know the creature itself until you have kept one as a pet. It takes readily to domestic life, and will soon accustom itself to our own omnivorous diet. Being a nocturnal animal, it is not often seen by country ramblers excepting in the twilight hours. During the whole of the day it remains in its retreat, rolled into a compact ball, with its sharp spines radiating in all directions. If, however, you meet with one, you may be pretty sure of finding another, for they live in pairs all the year round.

Early summer is the time in which to search for its nest. This is made of grass, moss, and leaves, covered in above to keep out

the rain, and usually concealed at no great depth in a hedge or bank.

Young Hedgehogs are very strange little things—that is, when *very* young. They are blind and naked, but a number of little pimple-like projections on the skin show where the spines will ultimately develop; and even when these spines have appeared they are at first soft and flexible.

We have one more animal of this order to consider, and that is the Mole. The little mounds of earth which we see so thickly

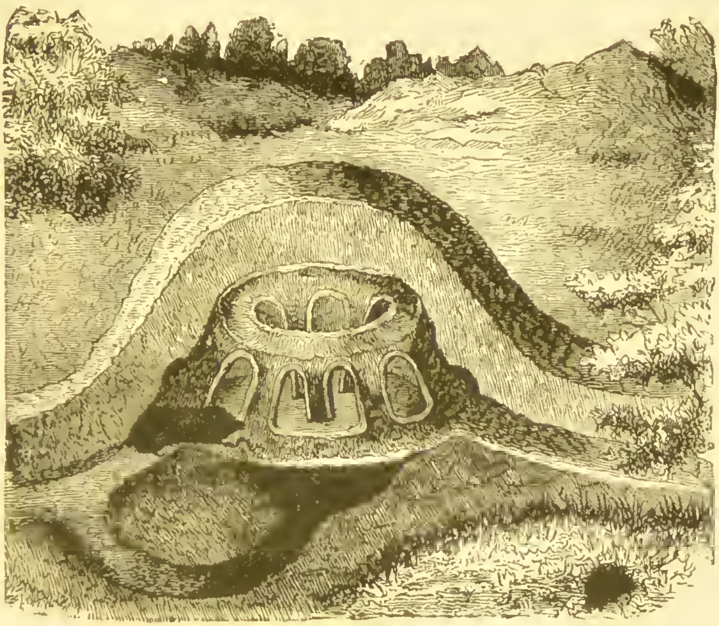


Fig. 422.—The Fortress and Galleries of the Mole.

scattered in our fields and moors, and which are commonly known as 'mole hills,' are not the abodes of Moles, but are simply formed of the earth thrown up at intervals as they burrow in search of the worms and grubs on which they subsist. There are generally a large number of these tunnels or burrows in the so-called 'hunting-ground' of a single colony of Moles, but all communicate with one central 'fortress,' which is generally situated under a large mound of earth in some sheltered spot. This fortress consists of a central chamber, surrounded by two circular galleries. The lower and

larger gallery has five passages leading into the upper and smaller one, and the latter communicates with the central chamber by three tunnels. Then there is always a fourth tunnel leading downward from the central chamber; and this one afterwards bends upward and runs into the high road from the fortress to the hunting-ground.

You will observe that this complicated establishment has been termed a *fortress*, and not a *nest*. The reason is because it is used as a stronghold and a retreat in time of danger, and not for the rearing of the young. The true nests are to be found distributed

FIG. 423.—THE MOLE.

along the burrows of the hunting-ground, often at some distance from it.

As a rule the burrows run horizontally very near the surface, but the mining operations of the Mole have necessarily to be conducted in accordance with the movements of the worm. Thus, in very cold or in very dry seasons, the Moles have to dig considerably deeper than at other times.

Now let us examine the Mole itself. Put a live one on the ground, and you will be led to suppose that it is by no means active. But then you have the creature out of its element. Its legs are not adapted for walking on the surface of the ground, and its eyes cannot

bear the glare of broad daylight. You get a very different idea of the creature when it begins to burrow; for then its powerful fore feet, turned backward and upward, and admirably adapted for shovelling up the soil, enable it to disappear with amazing rapidity. The powerful and pointed snout also assists its subterranean movements.

I have heard many express the opinion that the Mole is blind. This idea probably arises from the fact that its small eyes are hidden by the closely set velvety fur. Its ears, too, are not easily seen without careful examination; for they are not provided with any external appendages. As the Mole burrows into the soil its fur remains perfectly clean, for it is so close that even the finest particles of earth could not fall into it; and the eyes and ears are further protected by a number of small bristles.

Quiet and harmless as the Mole seems to be when removed from its haunts, yet it must be described as one of the fiercest of British Mammals. These animals fight furiously, especially during the breeding season, at which time the mere meeting of two or more of the males is quite sufficient to constitute a *casus belli*.

Finger-winged Mammals

If one were to ask you which of the British Mammals you considered to occupy the highest position in the scale of life, you would probably name one of the larger quadrupeds, such as the fox, known to you not only as a beautifully formed and agile creature, but noted also for its wonderful sagacity and intelligence. But in this matter experienced naturalists would not be with you, for they are all agreed that the Bat is, next to man himself, the most highly organised of all our animals. To this decision they have undoubtedly been led by the wonderful development of the limbs as well as the acuteness of the senses of the Bat tribe.

Then there are many who still regard the Bat as a bird, simply on account of its aërial habits. But this delusion is at once dispelled when you examine one. Its fur-clad body so closely resembles that of a mouse that it has received the name of Flitter-mouse. Its wings are quite devoid of feathers, being formed of a delicate skin which extends between the long and slender fingers. And if any further proof is required to substantiate its relationship to the other creatures named in this chapter, just look into the snug little

nest if an opportunity affords itself, and see the little brood of sucklings, nourished like kittens with their mother's milk.

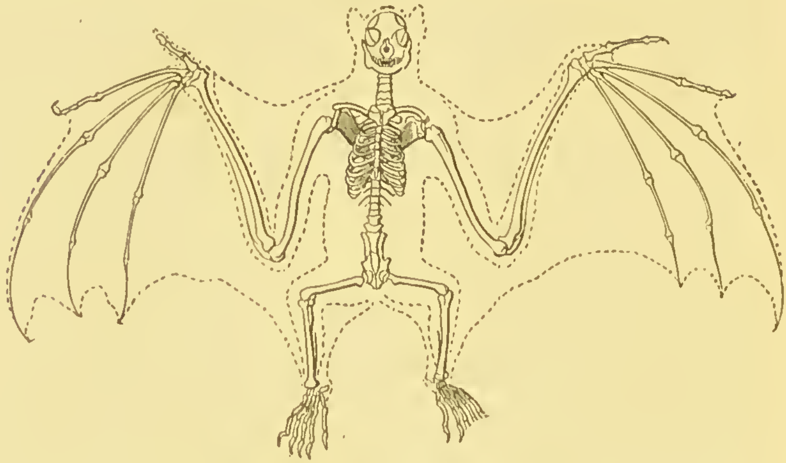


FIG. 424.—SKELETON OF THE BAT.

A short time since, I was repairing to the railway station for the homeward journey after a pleasant day with the butterflies. It was

FIG. 425.—BAT ON THE WING.

getting dark, and, with net still in hand, I maintained a sharp look-out for moths on the wing. Then the keen shriek of Bats caught my ear, and the thought occurred to me that I might succeed in

netting one of these nimble flitterers as it passed to and fro in search of insects. But this proved no easy task; for, although I remained as still as possible, and kept under the dark shadow of a thick tree, yet the extreme sensitiveness of the membrane of the Bat's wings warned them of the sweeping of the net by the movements it produced in the air. I succeeded at last in catching one, but the shock seemed to have been too much for the poor creature, for it did not survive more than a day or two after its capture.

Bats have very strange ways, and you cannot but be interested in their peculiar habits if you care to include them among your pets.

Although so agile on the wing, they are very awkward in their movements when they attempt to walk. In fact, they can do no more than *shuffle* their bodies along with their hind thumbs. Their usual position of rest is most remarkable. When about to settle, they climb up some perpendicular rough surface by means of the claws of their thumbs; and, when satisfied with their position, suspend themselves by their claws, head downwards. Tame Bats will also take and eat their food while in this position.

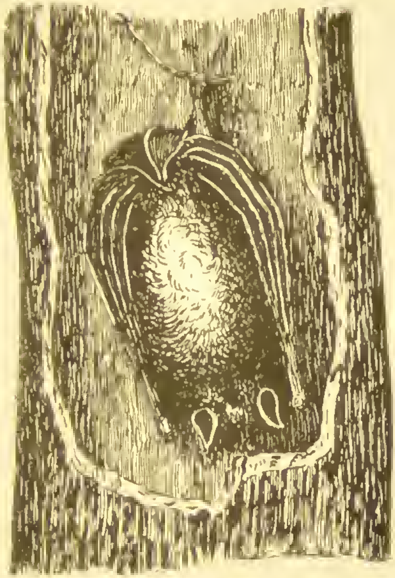


Fig. 426.—The Bat at Rest.

Should you ever desire to stuff a Bat, you will have an opportunity of noticing one or two interesting features of its internal anatomy. For instance, the powerful muscles of its breast, which are used in moving the wings, will remind you at once of the corresponding muscles in birds. A very simple dissection will also reveal the long and strong collar bones which help to support the fore limbs.

Several species of Bats inhabit our country, but they so closely resemble each other in general form and habits, that our short description applies equally well to all.

Preservation of Mammals

Small Mammals *may* be preserved entire in bottles or jars containing spirit, and although this plan is not often adopted by collectors, yet it has a distinct advantage in *one* respect over all others, for the internal organs are thus so perfectly preserved that at any future time the animal may be dissected, if desired, for the study of its anatomy.

But the usual plan is to preserve the skins only, and these may or may not be stuffed and mounted, according to the requirements of the owner. For general purposes of study and reference the empty or lightly stuffed skin may be laid in a cabinet or box, with the limbs neatly folded underneath; and this arrangement has the advantage of occupying a very small space. And whether the collection takes this form, or is to consist of a series of mounted specimens, but little need be said concerning the means employed; for the skinning, preservation, stuffing, and mounting of Mammals differs in no important details from the corresponding treatment of birds as given in our last chapter, except that the processes are much more simple. The first incision made in the skin should extend from the vent upwards, and should never be longer than is necessary for the removal of the body.

The skeletons of Mammals, and especially the skulls, are very interesting and instructive; and a series of these would form a very valuable collection. When a skeleton is required, the skin should first be completely removed without injury to the bony framework. The abdomen should then be opened, and all its organs removed. A partition will now be seen, fleshy round the sides, but thin and transparent in the centre, forming the floor of the chest. By cutting this away the heart and lungs can be exposed, and then pulled down from below by a pair of forceps, cutting through the windpipe in the throat if necessary to facilitate the removal. Nothing is now left but the empty carcase, consisting of the skeleton and the muscles. All the latter should be carefully cut away with the aid of scissers and scalpel as far as is possible, and the remains placed in a vessel of water till all the residue of the softer structures has decomposed and loosened away. While the decomposition is in progress, the specimen must be carefully examined at intervals, so that the process may be stopped before the ligaments that bind the various bones have given way. The removal of the partially decayed flesh may be assisted by the application of a soft brush.

The cartilages that form certain flexible portions of the framework should be preserved intact as far as possible, particularly those which, with the ribs, breastbone, and backbone, form the skeleton of the chest.

As soon as all the flesh has disappeared, and while the whole specimen is still entire, it should be taken from the water with the greatest of care, put into the position it is to finally assume, and then supported with a number of wires, pins, and string, till perfectly dry and stiff. It is sometimes impossible to preserve the whole skeleton in this way without the detachment of certain of the bones; but, when the parts have been dried, they are easily attached in their proper places with a little coaguline.

Plate XI

PART II

THE VEGETABLE WORLD

CHAPTER IX

SEA-WEEDS

Sea-weeds, or *Marine Algæ* as they are more properly styled, are not really flowers, nor do they bear blossoms of any kind; but they are so beautifully coloured, and their forms are so exquisitely graceful, that we will not carp at the name 'Flowers of the Sea' so often and so happily applied to them. At one time these 'low forms' of vegetable life were almost despised by botanists. They occupied such a mean position in the 'plant world' that they were regarded merely as beautiful weeds suitable for decorative purposes, and hardly worthy of a place in a really scientific collection. But things have now changed, and the modern botanist derives intense pleasure, and finds a great amount of instruction in the study of the structures and life histories of these charming plants.

The epicure and the poor sea-side cottager both seemed to have derived profit from the sea-weeds before the naturalist. The former has long enjoyed his famous 'laver sauce,' and the 'dulce' of the Highlander is both food and medicine. Even the sheep and cattle that graze on our rocky coasts have learned the value of the sea-weeds, and may be seen wandering among the rocks in search of some approved delicacy.

Collecting and Preserving Sea-weeds

Once more we look forward with extreme delight to a visit to the fascinating shore. And our anticipations are brightened by the determination to go with a definite object in view. Pleasant it

is to bask in the summer's sun, stretched out at full length on the sandy beach, or reclining on the rugged rocks, and lulled into a semi-slumber by the rolling of the breakers and the screaming of the distant fowl. But even this becomes too monotonous at last, and a weariness of mind and restlessness sets in.

Those who spend their sea-side holidays in this indefinite sort of way certainly derive some pleasure, and have the satisfaction that they get their maximum of bodily rest. But I am sure that their enjoyment is nothing compared with that of those who have learned to seek out and appreciate the marvellous and varied beauties of plant and animal life to be found on our coasts. The ardent naturalist, on the other hand, even though as yet young and inexperienced, looks forward to his outing with the most intense delight. The beautiful objects of which he has been reading, though, perhaps, at present almost unknown to him, make him yearn for a few hours on the rocks, and the days spent in making the preparations for the expected ramble are full of pleasing thoughts.

Let us, then, have a day with the beautiful 'flowers of the sea,' and make the necessary preparations for the collection and preservation of the expected harvest of 'weeds.'

First, then, what shall we need for the work on the sea-shore? A good thick pair of boots, not highly polished, but well rubbed with dubbin or some kind of grease; a stout and tough staff, with a hook at one end to assist us in reaching the weeds of the larger ponds, and of the deepest nooks beyond the low-water mark; a basket or a waterproof bag to contain the greater part of our collection; and a few wide-mouthed and well-corked bottles for the more delicate specimens. These we may consider to be absolutely necessary; but if we can either make or purchase a dredging-net, we stand a chance of procuring a better assortment of the rarer kinds that grow beyond the tide marks.

So much, then, for outdoor work. But we ought to look a little further ahead, and remember that many of our sea-weeds *must* be set within a few hours of collecting; and that, in all cases, the sooner this is done the better; so that, before making for the shore, we should have everything ready for the drying and mounting of the specimens on our return.

For this purpose we must be prepared with the following:—Several shallow dishes for washing, and one for mounting the weeds. The last should be large enough to receive the largest of the sheets of paper on which we intend to mount the specimens. For this no-

thing is better than the square porcelain developing dish used by the photographer; but, failing that, any kind of large shallow dish will answer the purpose. Next, we shall require a pair of forceps, a penknife, a camel-hair brush (flat preferred), a piece of sponge, a large supply of cartridge paper ready cut into pieces of convenient size, and plenty of absorbent paper—either blotting-paper or the 'sugar-paper' of the grocer, or botanical drying-paper if you can afford it. We shall also require some kind of press; but a number of deal boards, a little larger than the largest mounting sheets, will answer all purposes if heavy objects are at hand to place on top of them.

All these being ready, we have still two important matters to decide—Where shall we go? When shall we go? With regard to the former question you must know that a very great deal depends on the selection of your locality. Unbroken stretches of sandy coast are very unproductive, for in such places you get nothing save the damaged and partly decomposed weeds that have been thrown up by the breakers. You will do well to select a very wild and rocky coast, where the numerous ponds and sheltered nooks are almost covered with vegetable life. If you are entirely unfettered in your choice of a locality, by all means select a spot on the rocky coast of South Devon or Cornwall; but some very good collecting is also to be done on the western shores, on the coast of Northumberland, and round the Isle of Wight. The rugged shores of parts of Scotland and Ireland yield an abundance of species, but will probably be less accessible to the majority of my readers.

The collector's work on the shore is of a very simple character. All the little rock pools that come in his way should be carefully examined. Thus engaged, he follows the ebbing waters to their farthest limit; and then, for a short time only, he makes the most of his exceptional opportunities. Now is his time to search the surfaces of the rocks that are nearly always submerged, and to thrust his collecting hook into the sheltered chinks that are generally beyond his reach. Just at this time, too, an hour or so spent in examining the partially-exposed rocks from a small boat may add some valuable specimens to the store.

Then, as the water advances on the shore, the collector retraces his steps, always keeping as far seaward as possible, till at last he is driven to the comparatively barren rocks that are almost always exposed. Still his work is not quite done, for valuable specimens are often to be found among the line of rubbish that marks the limit

of the last flood. Here he will often meet with rare specimens that have been thrown up from the deep waters, some of which may be seen growing in small tufts on the fronds and stems of larger weeds. Should the 'algologist' arrive on the shore before the tide has receded far enough to allow him to start collecting at once, he should commence his day's work by turning over this miscellaneous collection at the high-water mark, for here he is likely to meet with very delicate rarities that are easily spoiled by a few hours' exposure to the sun; but even should he leave this part of his work to the end he will still find many specimens that have been preserved from injury by the masses that overlie them. After storms a large share of the collector's time may be devoted to these weeds cast up by the breakers, for at such times he will often secure some of the rarer kinds that are never to be found growing between the tide marks.

The young beginner at sea-weed collecting often makes the common mistake of collecting too much, so that he not only becomes overburdened by the vast accumulation of specimens, but also takes more than he could possibly mount while yet in good condition. If he has fallen into this error, the whole contents of the bag should be thrown out prior to leaving the beach, and a suitable selection replaced before a start is made homeward.

Now let us see what is to be done with the weeds at home. All are turned out into vessels of water—sea-water if possible—the delicate specimens being placed by themselves. All should be mounted before night if possible; but in any case start with the delicate weeds first.

Each one is now taken separately and floated in the mounting dish. The mounting paper is then slid beneath it, and the weed slowly lifted out of the water in an oblique position. This is repeated if the appearance of the specimen is not a natural one, and a camel-hair brush is used, if necessary, to arrange its parts. When it is thus transferred to the paper, it is set aside to drain, with a sponge or towel to absorb the water that runs off. The sheet is then laid on a piece of drying paper of the same size, and covered with a similar piece of fine calico, and on this another drying paper is placed. In this way the whole of the more delicate weeds are treated; and then, going back to the first specimen again, all the wet drying sheets are changed for fresh ones, and the specimens placed between the boards of the press.

When the weeds are perfectly dry, they will generally be found

firmly attached to the mounting sheets by their own natural gelatine, which, however, does not cause them to adhere to the calico that covered them. But some are of such a jelly-like nature that they are easily torn off with the calico, and these require special treatment. They may be dried without any pressure at all; or a gentle pressure may be applied for a short time while they are in a half-dried state. Others, again, such as the stony Corallines, have not sufficient natural gelatine to make them adhere, so these must be fixed to the mounting paper by some kind of cement. Skimmed milk answers well for the more flexible kinds, but some require a stronger fastener, such as isinglass or gum tragacanth.

There are yet a few peculiarities to be considered. Some weeds will never flatten well: they should be dried by pressing them in calico, and then mounted loosely on the sheets of paper. There are others that burst when pressure is applied, and must be treated in a similar manner. Lastly, you must not be disappointed if you find that some of your specimens lose their natural colours, for in certain cases this cannot be prevented. You will find green weeds turning brown, and brown ones turning green, and some even assuming a jet-black colour on drying.

Classification of Sea-weeds

Our sea-weeds are at last dry, and we lay them all out for a general inspection, with a hope that we shall be able to properly group them, and, if possible, to name all our species.

We find among them three prevailing colours—light green, red or purplish red, and olive green. Now, it will not do to group them hastily according to these tints, for they are divided according to the colour of their spores or fruits (which correspond to the seeds in higher plants) rather than that of their fronds or leaves. It so happens, however, that the colour of the former generally corresponds with that of the latter.

We thus get three classes:

1. *Chlorospermeæ*—with green spores. The whole plant usually of a light green colour, but sometimes either olive, purple, or black.

2. *Rhodospermeæ*—with red spores. The plant also generally red, but occasionally green.

3. *Melanospermeæ*—with olive spores. The whole plant generally olive green, but sometimes olive brown or yellow.

The first of these groups contains the two very common species of *Ulva*, known respectively as the Green Laver (Plate XI) and the Purple Laver. The latter is the true 'laver' of the English, the 'slaak' of the Scotch, and the 'sloke' of the Irish. Its delicate purple fronds are stewed for several hours, and eaten with butter and spices; or they are pickled and flavoured with oil and lemon juice. The fronds of the green laver are of a pale green colour, almost transparent, with a gracefully-wrinkled edge. They were also largely eaten at one time, and are so still in places where the purple species is scarce.

The tide pools between the high and low water limits almost always contain delicate green-jointed, hairy threads of various kinds of *Confervæ*, sometimes covering large surfaces, and floating gracefully in the water.

Another common green weed is the *Enteromorpha* (Plate XI), distinguished by its tubular fronds, often so very slender that they may easily be mistaken for those of the *Confervæ*.

The red weeds (*Rhodospermeæ*) include a largo number of attractive Algæ, very conspicuous in the tide pools from their bright red and purple tints. Among these the different kinds of *Ceramium* are very popular. Their fronds are threadlike, jointed, and branched; and the forked tips of the filaments aro generally curled towards each other. The common Red Ceramium is as beautiful as it is abundant. Its fruit may be seen in the form of littlo red swellings, each containing four tiny spores. It may be mentioned, in passing, that the nature of the fruits of the different Algæ should always be studied with the aid of a lens, for the classification of these plants is based chiefly on the structure of these; and specimens 'in fruit' aro always to be preferred for our collections when they can be obtained. Another species of Ceramium (*Diaphanum*) should also be mentioned, for its soft silky tufts and white but red-jointed stem render it one of the most handsome of our sea-weeds. Its deep-red spores are grouped in threes in the swollen joints of the stem.

FIG. 427. — *Ceramium diaphanum*, WITH PORTIONS MAGNIFIED.

There are over twenty species of *Callithamnion*, all small, but lovely shrubby weeds; some so small that they look like red velvet on the surface of the rock. These add much to the fairy-like

appearance of rock pools, and many of them look exceedingly beautiful when well mounted.

Near the low-water mark we meet with the Carrageen or Irish Moss (*Chrondus Crispus*, Plate XI), once so highly valued as a food for consumptives that it sold for over two shillings a pound. This weed is exceedingly variable both in colour and form, being either yellow, purple, or reddish brown; and either small and stunted, or growing luxuriantly in large dense masses. It seems particularly partial to rather brackish water, for it attains its greatest size in the estuaries of rivers. The common *Gigartina* is very like the Irish Moss, and is often sold under the same name. It may be distinguished by the grooved fronds and the broad forked tips.

We have already referred to the 'Dulce' as an article of diet in Scotland. This weed, known to the botanist as *Rhodymenia* or 'red membrane' (Plate XI), is also eaten in Ireland under the name of 'dillisk.' It is a very common alga, and its well-formed leathery fronds grow to some considerable size. The fruit takes the form of little patches of dots, or of berry-like bodies on the margins. A peculiar feature of this weed is the frondlets that grow out of the edges. It is a thick weed, and does not mount well. The young plants should be chosen for the collection, and even these will require a little isinglass to make them adhere.

If you want a genuine treasure for your collection, seek your opportunity at the extremest ebb of spring tide; and then. either wading in the water, or floating in a small boat, examine well the sheltered sides of overhanging rocks. Here you meet with the most beautiful of all the 'red weeds,' the Red Dock-leaf (Plate XI) with brilliant fronds varying from a few inches to a foot in length. The colour is blood-red (hence the scientific name *Sanguinea*), and the fronds, which are shaped somewhat like the leaves of the Dock, have a delicately-waved outline, and a distinct mid-rib. In summer the fronds are large, but in winter you see nothing but the stem and mid-rib, with the fruit on small tubercles or leaflets.

Perhaps the commonest of all the reds is the *Plocamium* or 'Braided Hair' (Plate XI); but, although common, it is certainly a very beautiful weed. Its pinky-red fronds are very much branched, and have no ribs or veins. This is the favourite weed with those who collect for decorations, its bright and pleasing colour being easily preserved. If you want to see this weed growing you must search at the lowest tide, but it is cast up on our beaches in great abundance everywhere.

Nitophyllum Punctatum is another very ornamental weed, generally found among the Algæ cast up by the waves; but you may see it growing at low-water mark. Its fronds are of a rose-red colour, almost without veins, and spotted all over with fruits. Its edges are cleft, waved, and plaited, and consequently refuse to lie flat on the collector's papers.

Perhaps the most curious of all the sea-weeds are the *Corallines*. Some of them certainly remind us of the branched corals, and this resemblance, together with their stony nature, led some naturalists to place them among the animals. There is a wonderful variety in the form and appearance of the different species. One of them, *Jania*, has slender interlacing fibres of a white, light green, or delicate pink colour, and looks much like a moss. It covers patches of rock in the tide pools, and often grows on the stems of larger weeds. A limy crust covers its vegetable structure completely, and its fruit may be observed between the forks of the branches. A second species (*Melobesia*) would never be regarded as a vegetable by the inexperienced collector, for it looks just like a covering of stone on rocks and weeds. Those that grow on weeds may be taken for your collection, but the specimens that grow on the rocks cannot be secured complete without chipping off the portion to which it is attached. You may easily convince yourself that the stony-looking masses are really plants by soaking them for a short time in diluted muriatic acid. This will soon remove the covering of carbonate of lime, and reveal a beautiful arrangement of vegetable fibres. The most familiar of the *Corallines* is undoubtedly the *Officinalis* (Plate XI). You will find this species fringing almost every tide pool; its white, pink, and purple hues presenting a most beautiful spectacle in combination with the bright greens and reds of the other weeds. The effect of acid is the same on this as on all the *Corallines*; all its protective calcareous matter is rapidly dissolved away, leaving nothing but the thread-like fronds; and during the action a quantity of carbonic-acid gas is given off. If you dry a piece of *Officinalis* in its natural state, and then hold it in the blue portion of a gas-flame, this same gas is driven off by the heat, and the almost pure lime that remains will glow with a brilliant white light—you produce, in fact, a miniature limelight. At times you will observe that the tips of the fronds of this weed are slightly swollen. These swellings are the fruits, and each contains a group of little spores.

We must now leave the 'red weeds' to examine a few of the

Melanospermeæ or olive-coloured Algæ, which include our gigantic oar-weeds and tangles. In this division, too, we meet with a wonderful variety of forms. Some (*Ectocarpus*) are tufts of brown

FIG. 428. *Ectocarpus siliculosus*, WITH SPORE-CASES ENLARGED.

FIG. 429.—*Ectocarpus granulosus*, WITH A PORTION MAGNIFIED.

shaggy threads attached to larger weeds; others (*Chorda*) are gelatinous or gristly and slimy threads, about the thickness of small twine; some (*Mesogloieæ*), when handled, feel and look like bundles of slimy worms; and some (*Cystoseira*) display a beautiful iridescence when examined in their native element.

The large dark olive Tangles that form a moving fringe on all our rocks seem to thrive best in the most boisterous seas. They are not generally favourite objects with collectors, but should always be carefully examined for tufts of small and rarer kinds that grow on them. The fragile Papery Tangle (*Fascia*) yields fronds more than a foot long, and yet the stem attaching them to the rock is no thicker than an ordinary pin.

Of course you have seen the common 'Sea-rope'—that string-like weed that attains such a great length; but did you ever observe a forest of this growth from the side of a boat in still water at low tide? If you are fond of diving in the sea, you can imagine yourself struggling in vain to reach the surface after having unwittingly plunged into the midst of a thick bed of these vegetable cords. They are often called 'dead men's lines,' and perhaps with some reason. The specimens we find on the shore are generally imperfect; but if you can succeed in pulling up a few as you lean over the side of a boat, you will see that they are slender and hairy at

the top, thickest in the middle, and almost as fine as a bristle at the root.

On some of our sandy shores we meet with rock pools with rugged sides and sandy bottoms, and fully exposed to the sun's rays. These are just the spots in which to search for the remarkable Peacock's Tail (*Padina pavonia*, Plate XI). The fan-like fronds shoot out from the sandy beds to a height of two or three inches. The edges are fringed with golden hairs, and the surfaces variegated with semicircles of a lighter colour. When under water it displays the most beautiful hues, the result of the decomposition of the rays that fall upon it.

The Bedderlocks (*Alaria*) is another edible weed. It thrives in the most stormy seas, where it exceeds twenty feet in length; but, although it withstands the fury of the waves, yet it is easily torn when handled. The part eaten is the mid-rib only; in Ireland this luxury is known as 'Murlins.'

The *Sporonchus* is a small and very beautiful weed, but it thrives in deep water, and is seldom seen by sea-side collectors except after a storm. Its bright olive feathery fronds look exceedingly pretty when gently waving in the water; but, unfortunately, we cannot preserve its natural colour. When exposed to the air, the fronds turn to a bright green; but even this is not permanent, for they finally change to brown. *Desmarestia* is another deep-water weed that undergoes similar changes in colour. It will also decompose other weeds with which it is brought into contact, and gives the mounting paper a greasy appearance.

FIG. 430.—*Sporonchus pedunculatus.*

The tough and coarse olive-brown sea-weeds that clothe the rocks so thickly between the tide marks are often entirely neglected by young collectors. They are considered to be far too common for the album. It is true that they do not admit of being mounted in the ordinary way, but that is no reason why they should not be studied at all. No one can truthfully say that they are not beautiful, and it is well to know that they are regarded as the most highly organised of all our Algæ. Even when you are not requiring specimens of these common plants, you should always remember that they afford shelter to many a rare treasure that lies concealed

beneath them. Most of these weeds are species of *Fucus* (Plate XI), and are known more commonly as 'Wracks,' 'Tangs,' and 'Wares.' Their leathery fronds are branched, and well supplied with air-vessels that buoy them up in the water, and the spores are usually contained in the yellow slimy swellings on their tips. Two of them —the Serrated Fucus, easily distinguished by the saw-like edge of the frond; and the Bladder Wrack, with very large air-vessels arranged in pairs—have a distinct mid-rib. Besides these there are two other common species. One is the Channelled Fucus, readily identified by the furrow in its stem, and the absence of air-vessels; and the other is the Knobbed Wrack, with air-vessels arranged singly in the stem.

We must be satisfied with brief notes on two more only: first, the Sea Oak, remarkable for its long pod-like air chambers, each divided into several compartments; and, lastly, the iridescent and many-branched Cystoseira of the south coast, the branches of which are full of small air-vessels. This weed is a pretty one, of an olive-green colour; but it dries black, and requires isinglass to make it adhere to the mounting paper.

CHAPTER X

FUNGI

We shall now deal with a peculiar group of plants called the *Fungi*, of which the common Mushroom is a very prominent member. We cannot say that they all resemble this well-known plant in general appearance, for a large number of them most certainly do not. In fact, they vary so remarkably in form and size that it would be almost useless for an inexperienced collector to start out on a Fungi-hunting expedition without previously picking up a little information about the varied structures and habitats of these interesting plants, unless he should be so fortunate as to secure the company of a friendly botanist. The Fungi are often popularly spoken of as the 'Mushroom Class'; and a young collector, possessed only of this knowledge, would reap a very poor harvest. He might collect a great many specimens, but they would very poorly represent the group as a whole.

Let us, then, before starting out for the field, examine some of these peculiar forms of vegetable life, so that we may be better able to recognise a Fungus when we see it.

First we will glance at a few of the most familiar species, starting with the common edible Mushroom. Its structure is apparently simple. Here is a thick and fleshy stem, supporting a circular cap (the *pileus*) that reminds us of our familiar friend the umbrella. On the under side of the cap you see a number of thin radiating plates running from the rim to the stem. These are called the gills, and on their surfaces are a large number of little bodies mounted on very short stalks, to be seen only with the aid of a good lens. Fungi, like the sea-weeds, are not flowering plants, and do not develop true seeds, but are reproduced by spores. The little bodies to which we have just referred are the spores of the Mushroom. We will collect some of them on a sheet of paper. By making a clean cut through the stem horizontally we can stand the

plant on its stalk on a small sheet of white paper. After letting it stay thus for some hours, we find a deposit of spores in the form of a purple dust beneath the spreading gills.

When the spores fall on moist ground they immediately grow, but not at once into Mushrooms. Instead thereof, they form an

FIG. 431.—THE COMMON MUSHROOM.

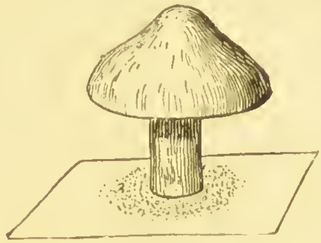


FIG. 432.—COLLECTING THE SPORES.

interlacing mass of cottony threads called the *mycelium*, or, more commonly, the *spawn*; and from this the Mushrooms grow rapidly in the following autumn.

Let us briefly trace the development of the Mushroom from the

FIG. 433.—THE FLY AGARIC (*Amanita muscaria*). UNDER TREES.

FIG. 434.—OSYTER MUSHROOM (*Agaricus ostreatus*). TRUNKS OF TREES.

spawn. First a little pear-shaped body rises above the ground; then this gradually expands, and we begin to make out the stem and cap. But the margin of the cap is at first joined to the stem, so that it looks more like a ball than an umbrella. At last the rim is set free, leaving a ring (the *annulus*) round the stem where it was

joined, and, gradually expanding, exposes the beautiful arrangement of the gills.

There are a large number of Fungi that very closely resemble the Mushroom. They are called the *Agarics*, and include the plants

Fig. 435.—*Agaricus vernus.* Size much reduced. Damp Woods.

Fig. 436.—*Agaricus odorus.* Woods.

popularly known as Toadstools and Frogstools. Some of them grow in open pastures and shady places; others prefer rotting stumps and logs. Although very similar in form, they vary in colour, and produce spores of different tints. Some (*Rubescens*) turn pinkish when

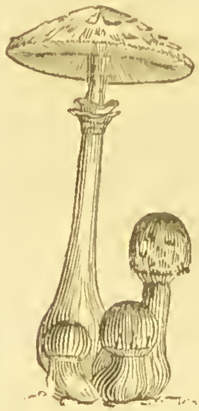


Fig. 437. Parasol Mushroom (*Agaricus procerus*). Open Spaces.

Fig. 438. The Gigantic Polyporus (*P. giganteus*). On Beech-trees.

bruised, and others (*Lactarius*) discharge a milky fluid when broken. The *Hygrophorus* is of a pretty scarlet colour, but yields white spores; *Armellaria* is pale yellow, and derives its nourishment from decaying stumps; and another family (*Collybia*) have black stems

with a soft velvety touch. Then there is the *Champignon* that shoots up in pasture lands, several plants often forming a pretty little 'Fairy-ring.'

The Agarics are the only Fungi which possess gills. In some cases (*Polyporci*) the spores are contained in a number of little pores that open beneath the cap. Here we also meet with stemless species, and species that appear to be all stem; some soft, fleshy, and juicy, and others hard and woody.

Fig. 439.—*Armillaria malleus.* Trunks of Trees.

Fig. 440.—*Pholiota squarrosa.* Woods.

We have already observed some remarkable variations in the structure of Fungi, but many more must be noted. We shall find some (*Auricularini*) which carry their spores on bristles, or (*Hydnei*) on spines that cover the under surfaces of their caps.

Fig. 441.—The Hedge-hog Hydnum (*H. erinaceum*).

Fig. 442. The Common Puff-ball (*Lycoperdon pyriforma*). Under Trees.

But what is this pear-shaped capsule that ejects a cloud of dust when pressed? It is the Puff-ball Fungus (*Lcycoperdon*), and is very common. When young it is fleshy throughout, but the interior is afterwards changed into a mass of dry fibres and spores. Here, again, is a dark brown patch of jelly-like substance, with little pro-

jections above, and a rough crape-like surface beneath. It is the 'Witches' Butter' (*Exidia*), a Fungus that lives on dead trees. Another gelatinous species is frequently seen on old elder and elm trees, in form something like a human ear. It has a smooth and velvety outer surface, but is wrinkled within, and is popularly known as the Jew's Ear.

Fungi-collectors do not have everything their own way, and the strange nature of some of their specimens often leads them into little

Fig. 443.—*Clavaria fusiformis.* Among Grass.

Fig. 444.—The Lurid Boletus (*B. luridus*). Section.

difficulties. The jelly-like kinds just mentioned sometimes give a little trouble by sticking to everything they touch; and the round-capped *Boleti*, though fairly solid when freshly gathered, soon run into a dark treacly mass. Some dissolve into an inky fluid, and others are speedily infested with mould. But, perhaps, worse than all these is the truly horrible odour of the common 'Stinkhorn' (*Phallus*). This plant is egg-shaped at first; but the membrane bursts, and up shoots a porous white stem, supporting a conical cap covered with slime. You will require specimens for your collection, but it is to be hoped that you will not find it necessary to journey homeward with your Stinkhorns in a crowded railway carriage. If you do, you may be sure that there will be rejoicings as you alight on the platform at your journey's end.

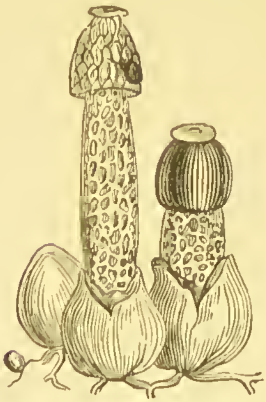


Fig. 445.—The Stinkhorn or Stinking Morel.

There are yet a variety of Fungi that introduce new features, but many of them would be passed by as being unworthy of the slightest consideration. A large number are microscopic, but an ordinary

botanist's pocket lens will reveal many a hidden beauty in what appears to be only a mass of dust or fibres.

The 'Dust Fungi' (*Coniomycetes*) appear as black powdery patches on stems and bark, and include the 'Bunt'—a disease of wheat, and the red mould of cheese. The 'Thread Fungi' (*Hyphomycetes*) include many of the 'Moulds' and 'Mildews.' The diseases of potatoes, parsnips, and many other crops, and the mould of stale bread are among the number.

Lastly, there are the Fungi that produce their spores in little bags or capsules, and not free on the surface. Among these may

Fig. 446.—*Æcidium berberidis*—A Dust Fungus, on a Leaf and a Flower; also its Cups magnified.

Fig. 447. Common Dung Mould.

be mentioned the mould of fruit preserves and paste; the mildew that covers damp ground, dunghills, and dead leaves; and the little red dots on sticks and twigs.

Perhaps sufficient has been said to show the young Fungus-hunter that he has to look for a great variety of forms, ranging from the merest speck to a fleshy mass of several pounds' weight. All are interesting, and the lower forms particularly so, if a microscope is at hand.

We will now give a few practical hints concerning the collecting and preserving of these plants.

Collecting Fungi

For this pursuit you will not require any very elaborate apparatus. A strong and sharp knife is necessary for the removal of the twigs, bark, or wood on which many of the Fungi grow; and a small garden trowel for digging out those that grow on the soil. All your specimens must be carefully isolated, or you are sure to have some completely spoiled by contact with others. For the small and

delicate species you should carry a number of chip boxes, and for the hardier kinds a quantity of soft paper and a good supply of fine string. These, together with a botanist's vasculum or a satchel slung over your shoulders, are all that are necessary; but a good pocket lens for the examination of the smaller species will form a valuable addition to your outfit.

But bear in mind where you are going, and see that you yourself are suitably clad for the work. Your harvest time is the damp and chilly autumn, and your collecting ground is often a swampy meadow or a dripping wood. Then get out your thick boots and leather leggings, and don't forget your great coat. The latter is not only useful to protect you from the bleak winds and the droppings from the trees, but the large pockets with which such garments so often abound will prove very useful when your vasculum is full. After heavy rains even the cumbersome gamp is a thing to be tolerated when you are working in thickly-wooded spots.

Your success in the field will depend largely on the day chosen for the hunt. The 'season' begins generally about the middle of September, and lasts till near Christmas, the month of October usually yielding the richest crop. But this season is not a fixed and certain period, for the Fungi will not make their appearance till the atmospheric conditions are exactly suitable to their needs. If the summer has been wet, and the autumn storms set in before their accustomed time, as they often do in our capricious climate, you may expect a splendid return before September begins, and even find the harvest nearly over before this month has terminated. But if, on the other hand, the summer has been very dry, and autumn storms have not preceded the winter frosts, you may not meet with much luck till the beginning of December. So you see that you must not only consult the weather as it is, when you are proposing a Fungi hunt, but also consider what it has been in the immediate past. At all times you may expect to do best during damp and foggy weather; but throughout the autumn and winter, and even in spring and summer, you will probably meet with stragglers here and there, both during the most unpromising weather, and in the most unlikely places.

The localities you search will be as variable as are the plants themselves. Sometimes you find yourself wading through the wet grass of a meadow, with eyes intently cast on the ground. Then you enter a leafy glade, and examine the trunks and twigs, and turn over the dead leaves. As you pass through lanes your gaze is

directed to the hedges, sometimes on the twigs and weather-beaten foliage, and sometimes on the baro banks.

But even this is not all. Every old log and rotting stump is a signal for stopping. Old arches, bridges, and tumble-down walls are to be visited: old quarries and neglected chalk-pits must be entered; saw-pits and deep ditches you reckon among your favoured spots; and the seething and reeking dunghill will often supply a rich harvest.

Each specimen, as you take it, must be carefully wrapped up in soft paper or put into a small box and numbered; and a note should be entered in your pocket-book of the locality, such note, of course, being similarly numbered. When you turn out your specimens at home, you should make a point of collecting the spores of your Agarics for examination and preservation; hence it is necessary that they should be packed in such a manner as to prevent the spores of the different species from getting mixed. Always put the large and heavy Fungi at the bottom of your vasculum, or you will find many of the smaller ones completely spoiled by the pressure.

Immediately on your return from the field the contents of the vasculum and collecting boxes should be spread out on a large sheet of paper, this being another precaution against contamination by contact and pressure. If you find signs of slugs or other vermin on any of the specimens, such specimens must receive immediate attention, or they will soon be eaten by the hungry marauders. If they are of a soft and fleshy nature, they may be plunged into a vessel of turpentine; but if hard and woody, a short roasting in a moderate oven will generally destroy all animal life. Even these precautions are not always sufficient, for many of the Fungi are infested with diminutive boarders that entirely escape observation. To get rid of these the best plan is to give all your specimens a momentary dip in a solution of corrosive sublimate in spirit; but, in the case of those from which you intend to obtain spores, the poison should be applied after these have been collected.

FIG. 448.—COLLECTING THE SPORES OF A FUNGUS.

Spores of the smaller Fungi are best collected in the way here illustrated, with the stem of the Fungus passing through a hole in a piece of paper supported on the neck of a bottle, a white paper being used for coloured

spores, and a black paper for the white ones. If the paper used be previously coated with gum, the spores may all be made to adhere firmly by moistening the surface with a jet of steam, or by breathing upon it. This will soften the gum, and every spore will be held fast when it dries. You thus get a neat little group that may be mounted by the side of the dried Fungus when the latter is ready.

Now let us see how the different kinds are to be preserved and mounted.

The hard and woody specimens require but little care. Simply lay them out before the fire till thoroughly dry, then dress them with the corrosive sublimate solution, and they are ready to lie in the trays of your cabinet. Thin sections may also be sawn or cut out from the middle of woody Fungi, and, after being treated as above, mounted on sheets of paper.

The softer Fungi may be preserved either by a dry or wet method. The latter is a very simple process, but seems to have few advocates on account of the large amount of space occupied by the necessary array of bottles and jars. Another disadvantage possessed by this method is the inconvenience attending the handling and inspection of your specimens from time to time; but, notwithstanding these drawbacks, the wet method has one redeeming feature, for it allows the soft Fungi to retain their natural form to perfection. Should you wish to try this plan you may use spirit as the preservative, or a solution of alum in which has been dissolved a few grains of corrosive sublimate.

But in all probability you will much prefer to mount your specimens dry. Then proceed as follows: Lay them all out on a sheet of paper for several hours to allow a part of the moisture to evaporate. Three or four hours will suffice for some, but others may be left for a day or two; and those that are covered with a sticky substance must be exposed to air till the surface is so dry that they will not stick to the drying paper when pressed.

After this partial drying, you lay them out between sheets of drying paper, and place them under a moderate pressure between the boards of your press.

Where you have more than one example of the same species, lay them out in such a manner as to display the parts to the best advantage. One may be set to show the upper surface of the pileus, another to exhibit the gills or tubes that contain the spores, some may be cut longitudinally to display the internal arrangement, and,

lastly, if possible, show the different stages in the development of the plant.

Several changes of drying paper will be required while the Fungi are in the press, but as soon as they are quite dry they are ready to be attached by a little gum to the mounting sheets of your herbarium. A label is then placed beside each specimen, containing the name, locality, date and other useful or interesting particulars; and the collection of spores, if you have any, also attached to the sheet.

CHAPTER XI

MOSSES

There is plenty of work for the young botanist at all seasons of the year. We have already seen that a rich harvest of Fungi generally awaits him just when the last flowers of autumn are shedding their fading petals. But his field-work during the winter season is by no means confined to these low forms of vegetable life; for then it is that the beautiful Mosses begin to display their greatest splendour.

Fig. 449.—*Sphagnum acutifolium.* Found in Bogs.

Fig. 450.—*Encalypta vulgaris.* On Walls.

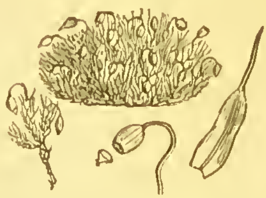


Fig. 451.—*Grimmia pulvinata.* On Walls and Roofs.

During the whole of the winter and spring he will meet with Mosses 'in flower' and 'in fruit' throughout all low-lying districts; and then, as the profusion of bright wild flowers announces the approach of summer, the collector will be busy with the later-fruiting Mosses in the more exposed and elevated spots.

Of course one may venture at once into the field without any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previous knowledge; but a few preparatory hints as to the general characteristics and peculiar habitats of these plants will undoubtedly add much to the success of the first Moss hunt; so we shall devote a short time to a brief notice of the distinctive features and peculiar ways of these interesting plants, that we may know where to direct our search, and to recognise a member of the group when it comes before us.

If you pluck a few of the common Mosses that lie in your path you will observe at a glance that they possess certain points of resemblance; but a more careful examination will always reveal a number of variations which serve to distinguish between the different species. Unlike the lower orders previously examined, they

FIG. 452.—*Grimmia apocarpa.* ON ROCKS AND TREES.

FIG. 453.—*Dicranum squarrosum.* WET SANDY BANKS.

FIG. 454.—*Orthotrichum affine.* ON TREES.

all have a distinct stem, but of very variable size and form. In some cases this stem reaches a length of many inches, but in others it is so short that it is scarcely noticeable. Some of the stems, too, are very much branched; while others are simple or unbranched.

All the Mosses, with the exception of the Bog Mosses (*Sphagnums*), have distinct roots by which they imbibe nourishment from the surfaces on which they grow.

Their leaves exhibit a great variety of form and arrangement. They are small and simple (undivided), and are arranged spirally on the stem. As a rule they are oval in form, or narrow and pointed like the head of a lance. When endeavouring to distinguish between the various kinds of Mosses you will do well to observe

most carefully the structure and disposition of their foliage. These and the manner of fruiting serve as our most useful aids in the determination of species. Sometimes the leaves spread out almost at right-angles to the stem; with other kinds they closely overlap one another like the tiles of a roof. Some have no mid-rib running

Fig. 455.—*Orthotrichum Lyellii.* On Trees.

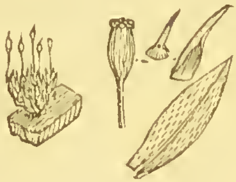

Fig. 456.—*Zygodon.* On Trees.

Fig. 457.—*Bartramia pomiformis.* On Heaths.

through the centre of the leaf, while others have this distinctly visible, and even projecting like a little bristle at the point.

The edges of the leaves are particularly variable. Some are toothed like a saw, and others are perfectly plain. In many instances the edges are curved over or under the blade; or the tips of

Fig. 458.—*Bartramia fontana.* Wet places.

Fig. 459.—*Bryum capillare.* On Heaths.

the leaves only are bent in this way, forming a kind of hook. Again, we shall often meet with leaves with their margins thickened all round; and others that are roughened by a number of little projections called *papillæ*.

Mosses are usually regarded as flowerless plants, but they certainly bear organs that closely resemble the flowers of higher

plants in the functions they perform. Sometimes you will see them conspicuously mounted on the summits of the stems in the form of little stars; in some plants they are small bud-like bodies lying in the axils of the leaves, and almost hidden amongst the foliage.

The fruits of Mosses consist of little capsules, containing a number of spores; but many species seldom bear any fruit at all, and are capable of being reproduced from little threads that grow on the leaves, or from little round bodies that are formed on the tips of the stalks or in the axils of leaves, or even from leaves that have fallen off the plant.

The spores do not give rise at once to the Moss plant, but at first produce green threads which look much like the confervæ of stagnant pools, and from these the mature plant is afterwards developed.

Collecting and Preserving Mosses

Now for the field. We shall not occupy much time in making preparations for the Moss-hunt, for our requirements are few and simple. First we secure one or two newspapers, and tear them up into pieces of three different sizes—four, six, and eight inches square. Then we number each one conspicuously with a coloured pencil, say from one up to fifty. These sheets may go into the pocket. Then we shall require a note-book in which to make useful entries concerning our specimens, and a pocket lens to examine them. A strong and sharp knife is absolutely necessary; and, lastly, an empty satchel or vasculum on the shoulder.

These few items being ready, there is only one other matter for consideration—Are our boots perfectly sound?—for some of the Mosses are sure to lead us into marshy and miry places.

Fig. 460.—*Polytrichum piliferum.* Heaths.

As we walk towards our selected hunting-ground, we turn our eyes to right and left, for we meet with Mosses on walls and palings, on tree-stumps and way-side banks. Each specimen is wrapped separately in one of our numbered papers, and a note of the locality, &c., is entered against that number in our pocket-book.

Thus we meet with several species on the way; but our success is much greater when we reach a well-chosen locality. A fruit orchard will yield some fine Mosses, especially if a few old apple trees are there. A shady copse, an old disused quarry or chalk-pit,

Fig. 461.—*Fissidens bryoides.* Moist Banks.

Fig. 462.—*Fissidens taxifolius.* Moist Banks.

old logs of wood lying on the ground, marshes and bogs, are all very attractive to the Moss hunter.

In all cases the entire plant should be collected, and this will often necessitate the removal of a piece of bark, or the upturning of more or less of the soil on which it grows. In the latter instance the greater portion of the soil may be gently shaken off before

Fig. 463.—*Leucodon sciuroides.* On Trees.

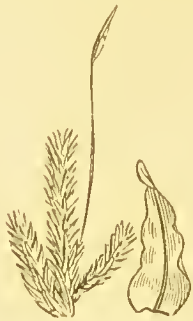

Fig. 464.—*Anomodon viticulosum.* Rocks and Trees.

wrapping the plant in paper. The species collected in marshes or bogs are often partly submerged in water, and much too wet for the satchel; but a great deal of the moisture may easily be squeezed out without doing any injury to the Moss.

Specimens 'in fruit' should always be collected when possible; but as some Mosses exhibit a very different appearance at this

time, both fertile and fruitless specimens should be taken in order to display this difference.

On your return your proceedings must be regulated according to the time at your disposal. If you have a few hours to spare, there is no reason why your Mosses should not be pressed at once; or a part only may be placed in the press, and the rest allowed to stand over for treatment at any future date.

Let us suppose that the latter is the more convenient plan, then we shall proceed as follows:

Separate the tufts, one by one, and wash out all traces of soil. Then, after removing as much moisture as you can by means of blotting-paper with a very gentle pressure, lay out your specimens neatly on sheets of drying paper, and write beside each one the reference number you gave it when collecting.

FIG. 465.—*Leskea polycarpa.*
ON TREES.

FIG. 466.—*Hypnum purum.*
WOODS AND DAMP BANKS.

All are presently to be placed in the drying press; but the greater pressure to which they will here be submitted will destroy the natural form of the fruit-capsules; therefore it will be advisable to remove a few capsules from each of the Mosses that are in fruit, and transfer them to small numbered envelopes. These will prove useful for future examination as occasion requires.

When you have dealt in this manner with all the specimens that are to be preserved at once, they may be placed in the press, with two or three sheets of drying paper between each layer of Mosses, and a weight of ten or twenty pounds on the top. Here they will remain till thoroughly dry, when they will be ready for fixing on the mounting sheets.

Now let us see what is to be done with those Mosses which,

through lack of leisure, or for want of space in the press, have been put aside. These must be thoroughly cleansed, and partially dried by means of blotting-paper or a towel. They should then be spread out to dry, each one lying on its numbered wrapping paper so that its identity may not be lost.

When quite dry, you may stow them away in any convenient place, and let them remain for any length of time till you find it convenient to prepare them as you did the others. When such time arrives, you have simply to soak them in water till their leaves have expanded to their natural form, and then proceed with them exactly as before.

Now a word or two concerning the mounting of Mosses. Take

FIG. 467.—*Hypnum piliferum.* WOODS AND BANKS.

FIG. 468.—*Hypnum triquetrum.* WOODS AND BANKS.

them from the drying sheets, and fix them on the mounting paper with a little thin gum. The mounting sheets should be of one uniform size. Each of the larger Mosses will then have a sheet to itself, but two or more of the smaller species may be mounted on the same one.

You will still retain the numbers of the collecting papers until your mounted specimens are labelled, otherwise the notes taken in the field will be worthless.

When the mounting is all done, you refer to your note-book, and write all the useful particulars you can under each species; and, lastly, each little envelope containing the fruit capsules should be gummed beside the Moss from which the fruit was obtained.

Such a collection of Mosses as I have described will be a source

of intense interest to the careful observer; and as the majority of species retain their natural form and colour for an indefinite period, it will remain a thing of joy and beauty for ever, always reminding one of the pleasant hours spent in the study of the outdoor world, and exhibiting the almost living freshness of Nature at times when we can no longer ramble abroad in search of her gems.

FIG. 469.—*Hypnum cupressiforme*. ROCKS AND TREES.

On Plate XII will be found a dozen coloured illustrations of British Mosses. Others are interspersed among the text. In the latter case enlarged figures are often given to better show the forms of the leaves and the nature of the capsules. These illustrations will not only serve to display the general characteristics of Mosses, but also aid the beginner in the identification of some of the common species.

CHAPTER XII

FERNS

Although Ferns are flowerless, and are never decorated with the brilliant tints of some of the higher plants, yet they are always attractive to the lovers of Nature, and often fill the first folios of a young botanist's herbarium. We need not go far to seek an explanation of these facts. In the first place, the lack of brilliant colours is compensated for by their great variety of form and exquisitely graceful outline; and, further, their popularity among young collectors is undoubtedly due to the ease with which they are preserved and mounted. Then, again, the colours of Ferns exhibit a

Fig. 470.—The Mountain Polypody (*Polypodium phegopteris*).

Fig. 471.—The Three-branched Polypody (*P. dryopteris*).

pleasing variety, in spite of the fact that they are all more or less green. Some are characterised by a beautiful but very delicate pale green, others are of a very dark shade, some are decidedly bluish, and others display such liberal blendings of brown that the green is hardly noticeable.

We will examine a few of these interesting plants in order to become familiar with their general characteristics.

First, then, we observe that they have well-developed roots by which to absorb food substances from the soil on which they grow. But we must not assume that the whole of the plant that is beneath

Plate XIII

the surface of the ground belongs to the root, for many have thick underground stems (*rhizomes*), some of which creep horizontally, occasionally giving rise to new plants as they grow onward. The true roots of Ferns are always composed of fibres, and invariably grow *down* into the soil in search of nutriment. Some Ferns have upright stems (of course we do not refer to the stems that bear the leaves or *fronds*, but to the main stems of the plant from which

FIG. 472.—THE BLACK SPLEENWORT FERN (*Asplenium nigrum*). PORTION OF THE PLANT, SHOWING THE RHIZOME, AND A FROND WITH SPORES.

these proceed); but these seldom peep above the soil in our native species. Again, we shall meet with creeping stems that keep above ground, covered with a brown coat of hairs or scales.

The most attractive part of the Fern, however, is that which I have already termed the 'leaf or *frond*.' The former of these two terms, however, is hardly a correct one to apply to the leaf-like portion of a Fern. It differs from the leaf of a flowering plant in one or two important particulars, and hence botanists have agreed

in the application of the term '*frond*' instead of leaf. Let us now see their reasons for so doing.

If you examine the under side of a mature Fern, you will observe a number of brown patches, arranged either along the sides of veins, or along the margin at the extremities of the veins. These patches are called *sori*, and are really clusters of minute *spores* from which future plants are developed. They correspond, in fact, to the seeds of the higher plants. Now, you know well that tree leaves do not bear seeds, but that these are contained in the fruit, which itself is a development of a part of a flower. Here, then, is one reason for the adoption of a special name for the leaf-like portions of Ferns.

Also, if you examine the fronds of Ferns in different stages of

FIG. 473.—THE NORTHERN HARD FERN (*Blechnum boreale*).

FIG. 474.—THE ALTERNATE SPLEENWORT (*Asplenium alternifolium*).

development, you will see that the mode of growth is very different from that of true leaves. Some, you will find, are rolled up into beautiful spirals; and others, like the Adder's Tongue (Plate XIII), are straight while yet undeveloped, but with the edges rolled in towards the central vein.

Before leaving the fronds we must observe a few other points of interest. First, as regards form, some are perfectly plain or undivided; or, as a botanist would have it, *entire*. Such are the fronds of the Hart's Tongue (Plate XIII), and the Adder's Tongue already mentioned. Others are deeply divided, but the incisions do not run quite to the central axis (*rachis*) of the frond. Some *are* divided quite to this axis; and, more than this, we find some of so intricate a nature that the *rachis* bears a number of

distinct parts that appear like complete fronds rather than portions only.

The arrangement of the veins in the fronds should also be observed. In some instances you will find these are straight, and run almost parallel with one another; but in many they are much branched, and form a network similar to that observed in the leaves of most of our flowering plants.

We must note yet another feature by which Ferns may be distinguished from the other flowerless plants:—If you cut through the main stem, making a clean transverse cut with a sharp knife or razor, you will see that a portion of its structure consists of soft cellular substance, and running through this are distinct bundles of

Fig. 475.—The Green Spleenwort (*Asplenium viride*).

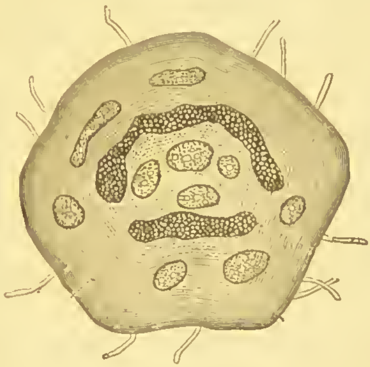

Fig. 476.—Transverse Section through the Stem of a Fern.

woody fibres, generally of a darker colour than the cellular ground structure. A lens will assist you in making out the arrangement of these two components of the stem; but if you possess a compound microscope, even a small one, you can get a most beautiful view of the structure by cutting a very thin slice and examining it on a slip of glass.

I strongly advise all my young readers who intend to study Ferns to try their hand at the cultivation of these interesting plants, and especially to watch them in their earlier stages of growth. A very little consideration given to their nature and requirements will render all experiments in this direction as easy as they are instructive. Your own observations have undoubtedly

shown you that Ferns thrive best in warm, moist, and shady spots. The necessary warmth and shade render them particularly suitable for indoor cultivation; but, with regard to the other essential, it must be remembered that a moist atmosphere is almost as requisite as a damp soil. Hence it is advisable to keep the Ferns under glass, so that the water-vapour rising from the soil and the fronds may saturate the air around them. The soil should be a good loam, mixed with a fair proportion of vegetable mould, and a liberal supply of coarse sand.

If you desire to watch the development of your Ferns from spores, prepare the soil in a shallow pan or box, and press it gently down till you have a very smooth surface. Then dust over the surface with ripe spores, and cover with glass as before recommended.

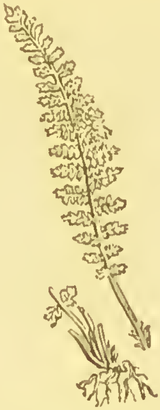

Fig. 477.—The Smooth Rock Spleenwort (*Asplenium fontanum*).

Fig. 478.—The Wall Rue (*Asplenium ruta-muraria*).

For watching the earlier stages, soil is not a necessity, for you may obtain equally good results by sowing the spores on a brick, or a rough absorbent stone, providing the surface is kept perpetually wet. Fig. 479 shows another plan, which may be recommended on account of its simplicity and cleanliness, and also because it enables one to watch the development of the young Ferns very conveniently. Here we have an inverted flower-pot, standing in a dish of water. On the top of the former stands a cup of water, over the edge of which hang a number of threads of worsted or darning-cotton. After seeing that the flower-pot is wet on all sides, it is dusted over with spores, and then covered with a bell-glass. The porous material of the flower-pot will now absorb water from the dish, and the

threads will also bring down a small but steady supply from the cup above. Thus the sown surface is kept continually moist, and the adhering spores gradually develop into pretty little Ferns.

But this transformation from spore to fern is not direct, for the

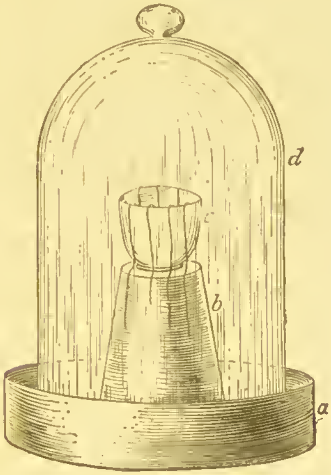

FIG. 479.—AN ARRANGEMENT FOR THE PROPAGATION OF FERNS.

a, shallow vessel containing water; *b*, inverted flower-pot; *c*, cup of water with hanging threads; *d*, bell glass.

FIG. 480.—A YOUNG FERN SPRINGING FROM THE PROTHALLIUM. NATURAL SIZE.

p, prothallium; *w*, first leaf; *r*, first root.

plant has to pass through an intermediate stage. Each spore first gives rise to a minute leaf-like body called the *prothallium*; and it is from this that root, stem, and fronds of the mature Fern are produced.

COLLECTING AND PRESERVING FERNS

Ferns thrive best in warm, moist, and shady situations; and your success as a collector of these charming plants will depend greatly on the choice of the localities you search. The most favourite hunting-grounds are the wooded and shady vales of the Isle of Wight and the West of England, Devon being particularly productive.

The apparatus required consists of the botanist's 'vasculum,' a strong knife, a garden trowel, and a note-book. Never omit the latter item, for the value of your collection as a means of study will

be considerably enhanced by particulars concerning the habitats and habits of the specimens.

Where practicable, always secure the complete plant; and in cases where this would form too bulky an article for easy transport, you should still dig it out whole, and make notes about roots and other parts which you find inconvenient to carry.

Of course the roots and underground stems of many species are far too thick and hard to be pressed for the ordinary method of mounting; but still they should be taken, for they may be dried without pressure, and then stored in drawers or boxes.

As far as possible you should secure specimens 'in fruit,' and

Fig. 481.—The Common Maidenhair (*Adiantum capillus-veneris*).

Fig. 482.—The Holly Fern (*Aspidium lonchitis*).

take at least two of each species, so that you may be able to show both sides when fixed to the herbarium sheets.

You will observe that many of the smaller kinds grow in pretty little groups or tufts, and you will often experience but little difficulty in taking and mounting the clusters complete. Here the knife will prove very serviceable, for you will frequently meet with clusters which issue from the deep and narrow chinks of a rocky bank, or from between the stones of an old wall where a trowel could not be forced.

Finally, do not strip off the shaggy covering of hairs and scales on the stems of your Ferns, for this would certainly destroy their natural appearance, without revealing any fresh beauty in the specimens.

Now for the drying. This should be done as soon as possible, for the more expeditious you are in this operation the better will the natural colours be preserved.

Turn out all the Ferns on a large sheet of paper, and proceed at once to remove all traces of soil from their roots. Separate all the thick roots and *rhizomes* that cannot be conveniently dried with pressure, and after fixing temporary labels to show the fronds to which each belongs, set them aside to dry in the sun. Several days will be required to get these perfectly dry, and when this is accomplished they should be arranged in your store-box or drawer with a liberal sprinkling of crushed camphor or naphthaline to prevent the intrusion of the ever watchful museum pests.

FIG. 483.—THE HAIRY WOODSIA (*Woodsia alpina*).

FIG. 484.—THE OSMUND ROYAL (*Osmunda regalis*).

Now take the smaller Ferns and the fronds of the larger ones, and lay them one by one on the drying sheets. Several specimens may be put on each sheet; in fact, they may be crowded closely provided there is no overlapping. Those fronds that are larger than the sheets used may be folded down, and thus preserved entire; but in the case of *very* large species, portions only can be taken. It is always a good plan to have the drying sheets of the same size as the mounting sheets that are to form the herbarium, for then you can easily manipulate the large fronds without the trouble of making measurements in order to adapt them to the latter. Eighteen inches by twelve is a very convenient size for herbarium sheets; but if the storing space at your disposal is very limited, you may find a slightly smaller size almost equally useful.

As each sheet of drying paper becomes filled, it may be placed at once in the press, and covered with two or three layers more to insure rapid drying. When all are placed in order, apply a very heavy pressure; and after a few days remove all the Ferns, and re-arrange them in fresh drying papers.

When perfectly dry they are ready for the mounting sheets. Only one species should, as a rule, be mounted on one sheet, to which it may be fixed by means of a needle and thread, or with narrow strips of gummed paper.

Nothing now remains but to affix the labels. These should contain the names of the species, the localities in which the specimens were collected, and other notes likely to prove either useful or interesting.

We cannot find room for an individual description of British Ferns, nor have we space for an account of their classification; but the coloured drawings on Plate XIII, and the figures interspersed with the hints in this short chapter, will help the young collector to identify some of his specimens.

Plate XVI

CHAPTER XIII

WILD FLOWERS

We must now turn our attention to the flowering plants that add so much beauty to our fields and hedgerows, that scatter such fragrance in our woods and glens, and so bounteously bedeck our banks, heaths, and moors.

I hope my young readers will not be disappointed if, at the outset, I venture to explain in simple language what a flowering plant really is. This assumes an amount of ignorance such as would hardly be admitted by anyone who has spent many hours in the fields and lanes. Here the bright colours of various wild flowers form objects so conspicuous and so interesting that one may easily convince oneself that it is a very simple matter to discriminate between the flowerless and the flower-bearing.

But have you observed what a remarkable variation exists in the showiness of different flowers? Some are so brilliantly coloured that they contrast most vividly with the surrounding foliage, while others are so small, and perhaps so largely partaking of the general greenness of the landscape, that they almost escape observation.

How many there are who have never seen the blossoms of the oak, and who would be surprised to learn that the grasses of our fields and wastes are all highly-developed flowering plants! True, in many cases the flowers are very small, and even uninteresting to those who do not know what to observe in them; but it must be remembered that neither size nor brightness of colour has anything to do with the estimation of the rank of a flower among its fellows.

We have to learn, then, exactly what is meant by the term 'flowering plant'; and in order to do this we must know precisely what a flower is. For this purpose we shall take one of our well-known wild flowers, and carefully examine its structure.

Our example shall be the Common Buttercup (*Ranunculus*

acris). Examine it well with the assistance of the accompanying illustrations. You see that it consists of a number of parts arranged in a series of whorls or circles round a common centre. The outer whorl is called the *calyx*, and is, in this case, composed of five oval green *sepals*. The second whorl is the beautiful bright yellow *corolla*, made up of five parts termed *petals*. Next to these are a large number of *stamens*, each consisting of a narrow stalk or *filament*, on which is mounted a little case (*anther*) that contains the pollen grains. Then, in the very centre of the flower is a mass of little green vessels called *carpels* that contain the seeds.

The central part of a flower is known as the *pistil* (fig. 486), and is, when perfect, composed of three distinct parts. The lower part

FIG. 485.—SECTION OF THE BUTTERCUP (*Ranunculus acris*).

c, calyx; co, corolla; s, stamens; p, pistil, with several carpels.

FIG. 486.—PISTIL THE LILY.

is the *ovary* or seed case, and may consist of one *carpel* or of several united together. The carpels are usually surmounted by a stalk called the *style*, on the top of which is a head termed the *stigma*.

Some flowers contain every one of the parts named, but others are deficient in one or more of them. Thus, some will have no filaments, so that the anthers, instead of being stalked, rest on one of the other organs. In others the stigma will not be mounted on a style, but will rest on the top of the ovary. Again, some flowers have no calyx, and some no corolla; the pistil or the stamens may also be absent.

These, then, are the principal organs that make up a perfect

flower; but the mere list of names would be very uninteresting without a knowledge of the uses of the various parts, so we will treat of these briefly. First, we must remember that the flower is the organ of reproduction; that is, it is the means by which fertile seeds are developed to give rise to future plants. The pistil and the stamens are both absolutely necessary for the production of fertile seeds; and the other parts, even though they be far more conspicuous, and the beauty of the flower due almost solely to their presence, are comparatively insignificant when we consider their functions.

We have seen that the seeds are developed in the broader part of the pistil; but these seeds, without the existence of the stamens, would be barren and useless. When the anther is ripe, it bursts, and the little pollen grains are thus set free. These are scattered by the wind, by insects, and by other agencies, so that they are, in one way or another, brought into contact with the stigma of a flower of the same kind, but not necessarily on the same plant.

As soon as a pollen grain touches the surface of a stigma, it is arrested by a gummy substance, and there it grows, sending a fine tube down into the ovary and into one of the seeds. A change now takes place in the seed thus penetrated; it is no longer barren and useless, but is '*fertilised*,' and becomes capable of producing a perfect plant after its kind as soon as it is placed under the conditions necessary for its development.

The calyx and the corolla also have their uses. Both are more or less protective, and serve to shield the more important organs from injury. They both completely surround the stamens and pistil during the earlier stages of the flower, the former generally forming a substantial covering over the young bud. The corolla of the showy blossoms also serves to attract bees and other insects that suck the sweet juices produced by the glands (*nectaries*) at the bases of the flowers; and these active-winged creatures, flying from flower to flower, with their hairy bodies covered with pollen, help to bring about the fertilisation of the seeds.

The stamens are spoken of as the *male organs*, and the pistil as the *female organ*; and any flower that possesses both stamens and pistil, whether it has or has not a calyx and corolla, may be regarded as a *perfect flower*.

As we become practically acquainted with our common flowering plants, we shall frequently meet with flowers that have stamens, but no pistil, and others that possess pistil but not stamens. The

former are called *male flowers*, since they have male organs only; and the latter are, for a similar reason, termed *female flowers.* Sometimes we find male flowers and female flowers both on the same plant, but often we shall meet with plants of the same species, some of which have male flowers only, and the others with female flowers only. In such cases it is, of course, absolutely necessary for the fertilisation of the seeds that pollen cells be transferred from plant to plant.

Now that we have learned the nature of a true flower, we ought to find no difficulty in distinguishing between a flowering and a flowerless plant. We have already dealt with the chief divisions of the latter, and the former, which we have now to consider, includes all those plants which are designated by the popular terms 'herbs' and 'weeds,' together with all our grasses, shrubs, and forest-trees.

Our intention is to make a pleasant study of these flowering plants, to search them out in the fields, woods, heaths, &c., and to preserve a collection of them for our observations at home during the dreary winter months when scarcely a blossom of any kind is to be met with out of doors. But in order that we may be able to do this intelligently, it is necessary that we should know something of the structure of all the various parts of plants; for without this knowledge we should not be able to make any use of the simplest descriptions of the characteristics that form the basis of classification. So we will now examine the principal parts of a plant.

Let us start with the root—that part of the plant which serves to fix it in the soil, and which absorbs nourishment from that soil. We shall meet with a great variety of forms among these, some simple and others branched; some consisting of delicate fibres, and others thick and fleshy.

As a rule the roots descend into the soil, and this feature often leads to the supposition that all the parts of a plant that lie beneath the surface must necessarily belong to the root. But this is a mistake, for many plants have underground stems. Such being the case, how are we to distinguish between these two parts? This is easy enough; for underground stems, like those which shoot upwards into the air, give rise to buds, which develop into new plants or new branches; but roots have no buds. The potato is an interesting case in point. In this plant we observe three distinct kinds of stems. One of these is the ascending green stem that bears the leaves, flowers, and fruit; and in addition to this there are creeping

underground stems which develop buds as they grow, and also the *tubers* which we eat—tuberous stems, the 'eyes' of which are buds, each one capable of producing a new plant.

One common form of creeping underground stem is called the *rhizome* (fig. 487). It creeps horizontally, just below the surface of the ground, giving off buds from the upper side, and sending down roots from the lower.

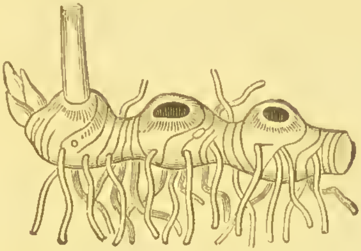

FIG. 487.—RHIZOME OF SOLOMON'S SEAL.

FIG. 488.—SIMPLE LEAF OF THE OAK.

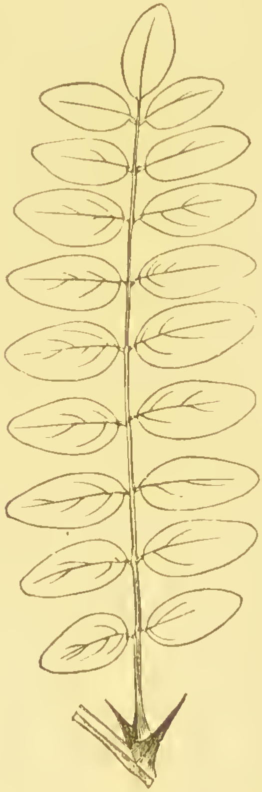

FIG. 489.—COMPOUND LEAF OF ACACIA.

The aërial stems, too, exhibit a variety of features. Some throw off 'runners' or 'offshoots' which develop new roots and stems at points where they touch the soil. Some grow very high, while others are so short that the leaves appear to arise directly from the root. Some stems are so thin and slender that they are quite incapable of supporting the weight of the rest of the plant; hence

they must either creep along the ground or attach themselves to some neighbouring object by means of suckers, as is the case with the ivy, or by twining themselves round their support like the convolvulus, or by developing *tendrils* like the vine.

The forms of leaves and the arrangement of their veins are so variable and so interesting that a young student of botany will find it instructive to make a separate collection of these organs alone. They should be arranged in two series, one containing *simple* leaves—that is, leaves with only one blade; and the other containing *compound* leaves—those which consist of a number of distinct leaflets, each one having its own stalk (fig. 489). This collection should also be made to illustrate all the different kinds of edges, such as the toothed, wavy, sawlike, spiny, and plain edges.

We have already learnt the general arrangement of the parts of a perfect flower; but, since the flowers are the organs of reproduction, you may easily understand that they would naturally be regarded as the most important parts of flowering plants, and that their varying structure would afford the principal means of classification. Hence the study of the blossoms must be made a very important part of a young botanist's work. A careful examination of the number and form of the parts of flowers, and of the relation they bear to one another, will, with the assistance of our table of the prominent features of the chief orders, enable you to classify many of your preserved specimens.

Now a few words about *fruits*. Every wild flowering plant bears fruit of some kind or other; and this is simply the ripened pistil. The beautiful petals may have been shed, and the flower, having lost its brightness, may be described as dead; but now it is that the pistil is ripening, and the seeds within it are gradually developing towards their mature condition.

In fruits we observe that seeds are not disposed indiscriminately, but that they are attached at definite points or along definite lines. These lines or points of attachment are called *placentæ*.

Since we shall often find it necessary to call attention to various fruits, we will now learn the names and characteristics of the commoner kinds.

Figs. 490 and 491 represent fruits that open when ripe, thus allowing the seeds to fall out. They are called *capsules*. Fig. 492 represents a *pod*; and fig. 493 a *siliqua*. You will see that the former has a placenta on one side only, and that the valves of the latter separate from a frame to which seeds are attached on both

sides. Fig. 494 shows a winged fruit (*samara*), capable of being carried considerable distances by the wind. Stone-fruits, such as the Plum, are called *drupes*; and the fleshy apple-like kinds are known as *pomes*. Hard and dry seed-like fruits are called *nuts*;

FIG. 490.—CAPSULE OF POPPY.

FIG. 491.—CAPSULE OF PRIMULA.

FIG. 492.—POD OF THE PEA.

FIG. 493.—SILIQUA OF WALLFLOWER.

and those that contain a number of seeds imbedded in a soft and juicy interior are *berries*.

Now, having noticed a few simple points of structure that characterise the flowering plants, we will make ourselves acquainted

FIG. 494. SAMARA OF MAPLE.

with the *modus operandi* of the collector. In the present instance we shall have nothing to say about either Grasses or Forest-trees; for, from a collector's point of view, these are more conveniently dealt with separately.

Collecting and Preserving Wild Flowers

Little need be said concerning the localities in which search for wild flowers should be made, for they are to be found everywhere. The most barren spots possess their species, some even showing a marked preference for places where hardly a vestige of soil clothes the rocks. But even though flowers may truly be said to grow everywhere, yet a knowledge of their favourite habitats will prove extremely useful at times when we are searching for certain desired species. Some prefer the darkest woods, while others are only to be found in spots exposed to the full sun; and meadows, cornfields, shady banks, ditches, ponds, streams, and the sea-shore, all bring forth their own peculiar flowers.

Your collecting apparatus will be much the same as that used for collecting Ferns, viz.: a rather large vasculum, a trowel, a knife, and a note-book. A few small boxes will also be useful to contain specimens of small and delicate plants, as well as such ripe fruits as you may meet with.

The instructions given for collecting Ferns also apply largely to flowering plants, but the following additional hints should be observed:—

Do not be satisfied with flowers only, but take the complete plant wherever possible. Let your specimens be such as illustrate the various stages of growth. A fully-formed plant bearing flower buds, open blossoms, and also the fruit more or less advanced, will, if such can be obtained, form a very valuable specimen; but it may be necessary to take two or more plants of each species in some cases to show all this. Then, with regard to very large plants, you must be careful to select such parts for your herbarium as shall *illustrate* the whole. Thus, in many cases, the newer leaves are very different in form from the older ones near the base.

Again, very young seedlings are extremely instructive; and you are sure to meet with many of these during your rambles. They often differ so much from the mature plant that identification is impossible except by those who have studied the development of the embryos; and for this reason I would strongly recommend young collectors to raise them from seeds that they themselves have taken from mature plants. How interesting it will be to see these little seedlings with their cotyledons, their first developing buds, and their young roots, side by side with the perfect plants on the sheets of your herbarium!

The method of drying and mounting wild flowers is just the same as that described in dealing with Ferns, only, of course, much care will have to be taken in so arranging the parts of flowers that they may be of use for future examination.

Ripe fruits and seeds, if small, may be preserved in little envelopes attached to the mounting sheets; and such as are too large to admit of this may be stored in drawers or boxes.

Perhaps this will be the best place to introduce a few words on the construction and management of the herbarium; but it must be remembered that the value of a collection of plants depends not on the money expended and the art displayed in a massive and ornamental case for your sheets, but rather on the care bestowed on the preservation and scientific arrangement of the specimens.

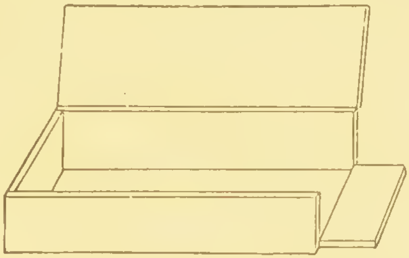

Fig. 495.—Box for Herbarium Sheets.

I will describe one simple form of herbarium that may be constructed by almost anyone, and yet answer all purposes just as well as the most elaborate cabinet.

Construct a box just large enough to contain your sheets loosely and about six or eight inches deep. The top should be hinged just as in an ordinary box, and one of the ends also made to open as shown in fig. 495. You will see at once that such an arrangement will not only allow you to readily lift out the whole contents bodily, but also to slide out any of the sheets you may have occasion to require.

One such box will give you a start; and then you may keep pace with the accumulation of specimens by making others of exactly the same pattern as they become necessary.

A number of these boxes, all of uniform size and pattern, would not form a very unsightly pile; and the whole may at any time be inclosed in a cupboard or any kind of receptacle constructed specially for them.

If you adopt this plan, you will at first have plants of all orders in one box; but your growing collection will soon give you an opportunity of studying practically the principles of classification by the arrangement of your own specimens.

I will give a few suggestions on this matter, but it must be remembered that the arrangement of a collection of natural history objects should never be considered complete. As your museum grows you will have to be continually overhauling your specimens in order to get all new arrivals in their proper places.

First, then, let each botanical specimen be fixed in a *folded* sheet, so that you may be able to slide any one out of its box without injury. Then write, *inside*, the name of the plant and any other useful information. Put the name only on the right bottom corner *outside*; you will then be able to select any specimen required by simply raising the corners slightly as the sheets lie in the box. Again, let all the plants representing the same order be placed in a folded sheet, with the name of the order outside; and you will find it very convenient to have sheets of different colours as far as possible for this purpose, not only for the sake of distinctness, but you will soon learn to know the orders by the tints of the sheets containing them. Lastly, put on the outside of each box the name of the class and that of the order or orders of the plants it contains.

Some collectors deem it necessary to poison all their plants in order to keep them free from the ravages of museum pests. This end is usually accomplished by brushing over all their specimens with a solution of corrosive sublimate. But, as a rule, a liberal dusting with powdered camphor or naphthaline will do as well; and it is far better to avoid the use of such deadly poisons as the sublimate if possible. However, both camphor and naphthaline are very volatile substances, and will consequently disappear entirely sooner or later; hence an occasional renewal of these insecticides is necessary.

Classification of Wild Flowers

I have said that the flowers collected should be arranged according to their classes and orders, but this will entail a little study on the part of the collector; and I will now endeavour to give, in as brief and as simple a form as possible, some of the elementary principles which should guide you in this important and interesting branch of your work.

First, then, a word or two about the classes. Flowering plants are divided into two classes: the *Monocotyledons* and the *Dicotyledons*. These two names are derived from the manner in which the seeds of the respective groups germinate, and are easily under-

stood by those who take the trouble to watch the development of the young plants. Take a few beans and some grains of wheat, sow them in pots of sand, sawdust, or cocoa-nut fibre, and keep them in a moist condition. Then, by the removal of one of each at intervals of a day or two, you are enabled to witness the various stages of growth.

You will observe that the bean splits into two, and that each part forms a thick fleshy leaf—the *seed-leaf* or *cotyledon*—which supplies nourishment to the young plant, while its root is as yet incapable of supporting it. Thus you will understand the application of the term *Dicotyledonous* (having two *cotyledons*) to all such seeds.

The grain of wheat, on the other hand, gives rise to only one *cotyledon*, and is a type of the *Monocotyledonous* flowering plants.

FIG. 496.—A YOUNG BEAN PLANT.

a b, cotyledons ; *c d*, leaves ; *e*, bud.

There are other characteristics by which we can distinguish between these two great divisions of flowering plants. Thus, the *Monocotyledons* have leaves with parallel veins, and the parts of the flowers are generally arranged in sets of three or six ; but the *Dicotyledons* have leaves with veins arranged in a network, and the parts of the flowers generally in fours and fives or their multiples.

These two great classes are subdivided into orders; and the number of orders is so large that a detailed description of their distinguishing characteristics and an individual mention of the British members of them would require a whole treatise to itself. Consequently we can do no more now than briefly mention a few of those orders that include the wild flowers most likely to be met with.

DICOTYLEDONS

Order 1. *Ranunculaceæ* or *Crowfoots*

General characters.—Sepals distinct and generally 5. Petals 5 or more. Many stamens, free from the calyx. Carpels many and distinct.

This order includes the Crowfoots (Plate XIV), Traveller's Joy, Meadow Rue, Pheasant's Eye, Anemones (Plate XIV), Larkspur, Marsh Marigold, and a number of other common wild flowers.

Fig. 497.—Marsh Marigold.

Fig. 498.—Traveller's Joy.

Order 2. *Cruciferæ* or *Crucifers*

General characters.—Sepals 4. Petals 4, and arranged like a cross. Stamens 6, 4 longer than the other 2. Fruit pouch-like or pod-like.

Fig. 499.—The Wallflower.

Examples.—Shepherd's Purse, Water Cress, Mustard, Wall-flower, Wild Cabbage, Rape, Turnip, Wild Radish, &c.

Plate XVII

Order 3. *Violaceæ—Violets*

General characters.—Sepals 5. Petals 5, unequal, the lower one prolonged backward into a spur. Stamens 5.

This order includes the Violets (Plate XIV) and Pansies.

Order 4. *Caryophyllaceæ* or *Clove Pink Order*

General characters.—Sepals and Petals 4 or 5. Stamens 8 or 10. Stem swollen at the origins of the leaves.

FIG. 500.—COMMON CHICKWEED.

FIG. 501.—MOUSE-EAR CHICKWEED.

Flowers included : Pinks, Campions, Mouse-ear Chickweed, Stitchworts, Common Chickweed, Sandworts, &c.

In all the above orders the stamens are attached under the pistil.

Order 5. *Leguminosæ* or *Leguminous Plants*

General characters.—Flowers irregular and butterfly-like. Sepals 4 or 5, united. Petals 5, irregular. Stamens 10—united into one or two bundles.

Furze, Broom (Plate XIV), Vetches (Plate XV), Trefoils (Plate XVI), and Clovers (Plate XIV), all belong to this order.

Order 6. *Rosaceæ—Roses*

Sepals 4 or 5. Petals 5. Many stamens and carpels.

Includes the Cinquefoils, Plum, Cherry, Sloe, Strawberry, Blackberry, Raspberry, Roses (Plate XV), Sweet-briar, Pear, Apple, and Willow-herbs.

Order 7. *Crassulaceæ – Stonecrops and Houseleeks*

Sepals and Petals from 4 to 12 in number. Stamens 3 to 20, inserted into the bases of the sepals. Flowers starlike.

Includes the Stonecrops and Houseleeks.

FIG. 502. COMMON STONECROP.

FIG. 503.—COMMON HOUSELEEK.

Order 8. *Umbelliferæ*

Flowers arranged in *umbels* (groups of flowers, the stalks of which all radiate from one point). Sepals, if any, 5 in number. Petals and stamens 5. Petals and stamens attached above the ovary.

This extensive order contains the Hemlock, Fool's Parsley,

FIG. 504.—COMMON HEMLOCK.

FIG. 505.—WILD CARROT.

Water Dropwort, Sea Holly (Plate XVI), Hedge Parsley, Fennel, Wild Carrot, Hare's Ear, and many other wild flowers.

Plate XVIII

In Orders 5 to 8 inclusive the petals are separate, and are arranged either around or upon the ovary.

FIG. 506.—FOOL'S PARSLEY.

Order 9. *Compositæ—Composite Flowers*

Flowerets collected together into dense clusters or *heads*. No calyx. Corolla tubular or strap-shaped. Stamens 4 or 5, their anthers united into a tube around the style.

FIG. 507.—COMMON SOW-THISTLE.

Among the flowers of this order are the Sow-thistle, Daisy, Dandelion, Burdock, Cat's-ear, Hawkweed, Thistles, Bluebottle (Plate XV), Mugwort, Colt's-foot, Ox-eye, Corn Marigold (Plate XVI), Feverfew, Groundsel, and many others.

Order 10. *Scrophulariaceæ*

Calyx with 4 or 5 lobes. Corolla also with 4 or 5 lobes, but two of them generally lipped. Stamens 4, 2 longer and 2 shorter. Seeds contained in a capsule.

This order includes the Fig-wort, Toad-flax (Plate XVI), Mud-wort, Eyebright, Fox-glove (Plate XV), Yellow-rattle, Speedwell (Plate XVI), Mullein, Cow-wheat, &c.

Order 11. *Labiatæ*

Calyx cleft into five parts, or with 2 lips. Corolla with 2 lips. Stamens generally 4, 2 longer and 2 shorter, but sometimes only 2. Fruit consists of four small nuts at the base of the calyx.

Fig. 508.—Dead Nettle.

Fig. 509.—White Horehound.

Includes the Dead-nettle, Hemp-nettle, Mint, Thyme, Penny-royal, Horehound, Ground-Ivy, and Betony.

Order 12. *Boraginaceæ*

Calyx and corolla with 5 lobes. Stamens 5, inserted on the petals. Ovary of 4 parts. Fruit consists of 4 small nut-like bodies.

The most common wild flowers of this order are the Borage, Hound's-tongue, Scorpion Grass, Forget-me-not (Plate XV), Comfrey, Gromwell, Lung-wort, and Mad-wort.

FIG. 510.—SCORPION GRASS.

FIG. 511.—COMMON BORAGE.

Order 13. *Primulaceæ*

Calyx and corolla cleft into 4 to 7 parts. Stamens equal in number to the petals, on which they are inserted. Ovary undivided. Fruit a capsule, containing many seeds.

FIG. 512.—COMMON LOOSE-STRIFE.

Examples.—Cowslip, Oxlip, Primrose (Plate XIV), Pimpernel (Plate XVI), Loose-strife, Water Violet, and Sea Milk-wort.

In Orders 9 to 13 inclusive the petals of the corolla are united.

Order 14. *Chenopodiaceæ*

Flowers small. Calyx sometimes tubular. Corolla absent. Stamens opposite the sepals; generally 5, but sometimes only 1 or 2. Ovary containing only one seed.

The plants of this order are found chiefly in salt marshes. The

most common are the Goose-foot, Beet, Sea-blite, Salt-wort, Glass wort, Sea Purslane, and Orache.

FIG. 513.—PRICKLY SALTWORT.

FIG. 514.—GLASSWORT.

Order 15. *Polygonaceæ*

Male and female organs sometimes on separate flowers. Flowers often in *racemes* (stalked on a long axis). Sepals 3 to 6, and overlapping one another like the tiles of a roof. Stamens 5 to 8, inserted in the calyx.

In this order the flowers are all small. The commonest are the Knot-grass, Buckwheat, Dock, and Sorrel.

FIG. 515.—CURLED DOCK.

Order 16. *Amentaceæ*

Flowers in *catkins*. Male and female organs in separate flowers, but both generally on the same plant. In some, as in the Willow, the male and female flowers are on different plants. Calyx and corolla either absent or very slightly developed.

This order includes such trees and shrubs as the Sallow, Willow, Osier, Poplar, and Aspen (see Chapter XV).

In all plants of the last three orders the flowers are more or less incomplete.

MONOCOTYLEDONS

Order 17. *Orchidaceæ—Orchids*

Flowers irregular and *bisexual* (stamens and pistil both on one flower). Calyx coloured, consisting of 3 sepals. Petals 3, the lower one flattened and prolonged below into a spur. Stamens 1 or 2, united to the style. Root fleshy.

This order includes the various Orchids (Plate XIV), also the Bird's nest, Twayblade, and Lady's Tresses.

FIG. 516.—MAN ORCHIS.

FIG. 517.—STAR OF BETHLEHEM.

FIG. 518.—BUTCHER'S BROOM.

Order 18. *Liliaceæ—Lilyworts*

Calyx and corolla regular and coloured, sometimes uniting to form a tube, and divided into 6 parts. Stamens 6, arising from the calyx or corolla. Ovary of three cells. Leaves narrow, with parallel veins generally. Stem usually bulbous.

The chief British examples are the Wild Leek, Garlic, Star of Bethlehem, Wild Hyacinth (Plate XIV), Butcher's Broom, Fritillary, and Meadow Saffron.

Order 19. *Amaryllidaceæ*

Calyx and corolla of 6 parts. Stamens 6, arising from the sepals and petals. Ovary of three cells. Fruit a capsule. The root is bulbous, and the leaves long and narrow.

The Common Daffodil and the Snowdrop are the best-known flowers of this order.

The *Graminaceæ* or Grasses form such an extensive and popular order that a separate short chapter will be devoted to them. It will be convenient, too, to offer a few remarks on our Forest Trees separately ; for, although these are truly flowering plants, yet they form such a characteristic feature of our landscapes that we naturally consider them apart from the comparatively dwarfish 'herbs.'

Plate

HANHART LIT

CHAPTER XIV

GRASSES

THERE are those who would tell you that Grasses are not flowering plants, but that they are only a kind of clothing for the ground, consisting of an uninteresting mass of green stems and narrow leaves, useful enough in the fields and on the moors, where they give a pleasing verdure to the landscape, and a carpet-like softness under the feet, but in other places appearing persistently as trouble-some obnoxious weeds, causing no end of annoyance and care.

Now let us see if they are really flowering plants, and whether their blossoms are such that we should rank them among the beauties of Nature.

Here is the well-known Oat-grass, that will serve our purpose as well as any. We will pull off one of its spikelets, and examine its structure with the assistance of a hand lens. Outside we see two loose pointed leaves that exactly correspond with the calyx of the Buttercup, but which in Grasses are called *glumes.* Within these are another pair of leaves that represent the yellow corolla of the flower we studied, but are here termed *paleæ.* Then, within the paleæ, or projecting out between them, we observe three beautifully-formed stamens, surrounding a pistil with two curved feathery stigmas. But this is not all; for, standing out from

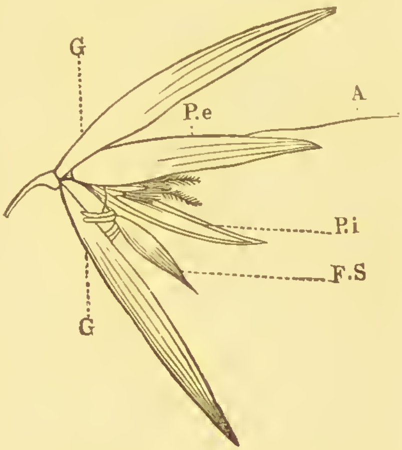

FIG. 519.—EXPANDED SPIKELET OF THE OAT, WITH A FERTILE AND A BARREN FLOWER.

G, glumes; *Pe*, outer pale; *Pi*, inner pale; *A*, awn; *FS*, sterile flower. Between the paleæ are the feathery stigmas.

the mid-rib of the outer pale, we see a stiff bristle. Such structures are very common in Grasses, and are known as *awns*. Again, between the inner pale and the glume on the same side we see a small barren flower—that is, a flower in which the organs of reproduction have not developed.

If you will now deal with other common Grasses as you have with this one—examine their spikes or spikelets with a lens and make out the parts of their flowers—you will soon find that these somewhat neglected plants will provide you with a most interesting study, and you will soon take a delight in the collection and

Fig. 520. Fertile Flower of the Oat, showing the Three Anthers and the Feathery Stigmas.

Fig. 521.—Section of the Oat-seed.

C, cotyledon ; *G*, young bud ; *R*, young root.

Fig. 522.—The Split Leaf-sheath of a Grass.

preservation of the gems that were at one time crushed beneath your feet without either a look or a thought.

We have thus far decided that Grasses are to be included with the flower-bearing plants (*Phanerogams*) ; but now comes the important question, 'What is a Grass ?' As a rule they are easily distinguished from the other flowering plants, but it will be as well to notice some of the precise characteristics by which they are to be distinguished. Then let us again take one of the common species for examination, but this time not the spikelet only, for we shall require the whole plant, root included.

Arising from the tuft of root-fibres we now trace a long and

slender round stem, jointed at intervals, and surrounded by the sheaths of the long and narrow leaves. If you cut through the stem with a sharp knife you will generally find that it is hollow or tubular, but with a partition stretching across it at each joint. The Sedges, which may be included with the true Grasses, differ in that they have solid stems of a triangular form, but the angles are partly hidden by the sheaths of the leaves which form true cylinders.

The leaves of Grasses are all long and narrow, with veins running side by side; and the uppermost leaf forms a kind of cradle in which the young buds are nursed.

The flowers are often arranged in what is termed a *spike*; that is, arranged without stalks along an axis. But in many we observe a number of branches, each bearing a few flowers only.

In most Grasses and Sedges each flower possesses both stamens and pistil, but in some we find what are termed male and female flowers. The number of stamens is usually three, and these add much to the beauty of the flowers for a short time, as they project beyond the glumes in the form of a light moving fringe. One of our commonest Grasses the Sweet Vernal—has only two stamens to each flower. This is one of our early blooming species, and may be found in all our hay-fields during the spring: in fact, it is the Grass that gives the sweetness to the odour of the hay.

Most of the Grasses have two pistils; and here, too, we may note an important exception in the case of the Mat Grass that covers our moors and hilly pastures so thickly, which has only one stigma.

Collecting and Preserving Grasses

Now let us wander away into the meadows and waste places to make a practical acquaintance with these interesting plants. We shall take with us a quantity of common porous paper—a few old newspapers will do well—folded into double sheets of uniform size, and placed in rather large folio. This, together with a garden trowel and a writing pencil, is all we shall require.

The first meadow we enter yields a number of pretty species. Here is the Meadow Fox Tail, with its fox-like brush covered with beautiful orange-coloured anthers. It is an early bloomer, but a little later in the season we shall meet with its less robust brother —the Slender Fox Tail. If we come across a pond we may also see

the Floating Fox Tail, with its rough stem, bent sharply at each joint, hanging over the surface of the water.

We begin at once to fill up our folio. Selecting a well-formed plant, we take it up by the root; and, if not too large, place the whole inside one of our double sheets. But if the plant is too large to admit of this, we get in as much as possible. If necessary, we cut off the root; and, after shaking out the soil, put it in beside the rest of the plant; but when we meet with a root that is too thick to be conveniently carried in our folio, we wrap it up in a separate piece of paper, and carry it in the pocket. On the *outside* of each sheet, as soon as it is occupied, we write down the locality in which the inclosed specimen was found, together with any other information that seems at the time to be worth remembering. A note should also be written on each paper in which we wrap a root, or a number may be placed on it corresponding with another written on the sheet containing the rest of the plant.

Now we continue our search; and ere long we are sure to come across the Cat's Tail, for this Grass forms a large proportion of all good pastures. It is not so tall as the Fox Tail, and its spike is much denser. If wandering near the coast we shall also obtain the Sea Cat's Tail, distinguished by its hairy leaves and small tapering spike.

The large tussocks of the Hair Grass, with delicate waving flowers, next attract our attention. This beautiful Grass is common in almost all pastures. We shall look out for other species of this family (*Aria*), among which are the Crested Hair, the Wavy Hair, and the Silver Hair, all of which are common.

The Meadow Soft Grass is also soon within our grasp, and after admiring its pinkish and woolly florets and hairy foliage it is given a place in our folio. We must also look out for the Creeping Soft Grass, distinguished by the hairy joints of the stem, and the creeping root. Both these grasses abound in bad pastures, but are not allowed to flourish by the careful agriculturist, as cattle do not like them.

The Fescue Grasses, on the other hand, are highly valued by farmers. These include a large number of species. The Meadow Fescue thrives well in low and moist pastures; and the Hard and Sheep's Fescues in hilly districts. The last of these is one of the best kinds for lawns.

The Common Meadow Grass, of which there are two kinds—the Rough and the Smooth—form generally the principal part of hay

Plate. XV.

crops. These are the troublesome weeds that are so constantly making their appearance in our gardens and paths.

Before taking leave of the meadow we shall probably be able to procure specimens of the Darnel and Rye Grasses, whose many-flowered spikelets, arranged alternately on each side of the stalk, are very familiar; also the Couch Grass and Wheat Grass, both members of one family, and the pretty Maiden Hair.

Now let us look for a dry and sandy bank, for here we shall meet with the Cock's Foot, the branched panicle of which somewhat resembles the claws of the monarch of the dung-hill; also the Dog's Tail, with florets arranged in pairs on the spike; the Bent Grass, with spreading panicle mounted on an upright stem; and the loosely-formed spikes of the Dog's Tooth.

Still we have not done, for there are yet those Grasses which love the margins of our ponds and boggy wastes, and others that delight in the salt marshes of the sea-shore, or in the wild and rugged moor; but we can do little more than mention their names. Among the water-lovers are the Marsh Bent Grass; the Sedges, and the Reed Canary Grass that accompanies them; the numerous Reeds, and the Reedy and Floating Sweet Grasses. In salt marshes we may expect to find the Cord Grass; the Hard Grass, with a stem twisted into many angles; the Green Beard Grass; and the Reflexed Sweet Grass. On moors we may look for the Heath Grass, with four florets on each spike; the Purple and Mountain Melics; and, on chalky uplands, the Blue Moor Grass. Lastly, in woods and glens we pluck the Drooping Melic, the Holy Grass (of the Scottish Glens), the Feathery Millet, and the tall Brome that will vie with some of ourselves in the matter of stature.

Having filled our folio, we wend our way homeward to examine and preserve the specimens. The contents of each sheet are now to be dealt with separately; and after carefully adjusting the leaves and flowers, the sheet is again closed, and placed on one side under a weighted board. So we deal with all our Grasses in turn till all are thus made ready for the press. This done, we take the folded sheets, one by one, and pile them on the bottom board of the press, with plenty of extra paper between them to absorb the moisture. When the pile is complete, the top board is laid on, and weighted with about ten or twenty pounds.

No special skill is required in preserving and drying Grasses; for, although many are decidedly delicate, yet none are easily injured

unless very roughly handled. They do not contain much moisture, and consequently they need not be kept under pressure nearly so long as other plants of a more succulent nature. Neither are they liable to changes in colour like some of the algæ and the higher flowering plants.

Nothing now remains but to mount and label the specimens when they are thoroughly dry; so, while they are yet in the drying-press, we must prepare a permanent home in which to lodge them. For this purpose we shall need a good supply of cartridge paper, and a neat folio which may be made by hinging together two pieces of milled board with a strip of leather.

The cartridge paper is now cut into sheets of such a size that, when doubled, they are very slightly smaller than the boards of the folio, which will then project a little over their edges like the covers of a book.

When all is ready, we take the Grasses from the drying-press one by one, and fasten each one inside its cartridge sheet by means of a few very narrow strips of gummed paper, and then, closing the sheet, write neatly, *outside*, the name of the specimen and the locality whence it was obtained. To this may be added the date of collecting, the nature of the soil on which it was found, and any other useful notes.

CHAPTER XV

OUR FOREST TREES

I WILL conclude our brief survey of the vegetable world by giving a few sketches and notes for the purpose of enabling my young readers to recognise the principal trees of our forests and woods.

The value of these as ornaments of the landscape cannot be over-estimated. And the lover of Nature need not be acquainted with the names and nature of the various trees in order to appreciate their general effect on the scenery. But it is a real pleasure, never-

FIG. 523.—THE COMMON OAK (*Quercus pedunculata*).

FIG. 524.—THE SESSILE-FRUITED OAK (*Q. sessiliflora*).

theless, to *know* them—to be able to call them by their names, and to observe the peculiarities of the different species as we pass them, or as we view them from some distant spot.

First and foremost we must necessarily place the grand old Oak, the majestic trunk and twisted branches of which are familiar to everybody. Its fruit too—the acorn—we know well. But the little green flowers are not so familiar, for they are not at all conspicuous among the bright green leaves which adorn the tree in the spring.

There are two species of Oak to be found in our country, both of which are here figured.

Belonging to the same natural order we have the smooth-barked and bristle-fruited Beech—another majestic tree, the leaves of which

FIG. 525.—LEAVES, FLOWER, AND FRUIT OF THE BEECH (*Fagus sylvatica*).

FIG. 526.—THE SWEET CHESTNUT (*Castenea vesca*).

exhibit the most beautiful of autumnal hues; also the sweet-fruited Chestnut, conspicuous by its glossy leaves and deeply-grooved bark, the Hazel, and the hard-timbered Hornbeam.

The Elm is so abundant and so widely distributed that you may

FIG. 527.—THE HAZEL (*Corylus avellana*).

FIG. 528.—THE HORNBEAM (*Ostrya vulgaris*).

be surprised to hear it is not a native of our country. It was introduced here during the Roman or the Norman period. We have two distinct species—the Common Elm and the Wych Elm. The latter is more spreading than the commoner one, and its leaves are larger and broader.

The Poplars are remarkable for the peculiar tremulous motion of the leaves when they are agitated by even the slightest breeze. This trembling is due partly to the length of the leaf-stalk, and partly to the fact that the stalk is flattened in a plane at right angles to the surface of the leaf.

Fig. 529.—The Common Elm (*Ulmus campestris*).

Fig. 530.—The White Poplar (*Populus alba*). Leaf and Flowers.

In the case of the White Poplar a very striking effect is produced by the quivering of the leaves, for the under surfaces are white, and form a strong contrast with the general green of the upper surfaces when reversed by a passing gust.

The Aspen is commonly known as the Trembling Poplar, since the quivering of the leaves is most conspicuous in this species.

Fig. 531.—Leaf and Flowers of the Black Poplar (*P. nigra*).

Fig. 532.—The White Willow (*Salix alba*).

The catkins of the Black and Lombardy Poplars, rendered showy by the bright red anthers, are thick on the trees in early spring, before a single leaf has unfolded, and cover the ground beneath with a soft and beautiful carpet. The latter of these two is the tall and spire-like tree so commonly planted in the suburbs of our large towns.

In the same order as the Poplars we have the different species of Willows, the chief of which are the White Willow, so called from the light under surface of the leaves; the Goat Willow or Broad-leaved Sallow; and the Osier, the young stems of which are used largely for making wicker-work.

Fig. 533.—The Broad-leaved Sallow (*S. caprea*).

Fig. 534.—The Osier (*S. viminalis*).

The Birch and Alder are allied trees of another order. We have two species of Birch—the Common and the 'Weeping.' They are both light and airy trees, with silvery bark, small leaves, and slender branches. The Ash is also of a light airy build; its wood is

Fig. 535.—The Common Birch (*Betula alba*).

Fig. 536.—The Alder (*Alnus glutinosa*).

very tough, and consequently in demand for walking-sticks, alpen-stocks, and the handles of tools.

Our cone-bearing trees include the funereal Yew—the dark and dismal occupant of almost every country churchyard; also the Larch; and the Scotch Fir or Pine, a fitting ornament to the bleak mountains of the northern parts of Britain.

The Maple and the Sycamore are two similar trees, both bearing palmate or hand-shaped leaves, and winged seeds that spin

FIG. 537.—THE ASH (*Fraxinus excelsior*).

FIG. 538.—THE YEW (*Taxus baccata*).

rapidly as they fall through the air. The figures given on p. 390 will serve to distinguish between them.

FIG. 539.—THE LARCH (*Larix communis*).

FIG. 540.—THE SCOTCH FIR (*Pinus sylvestris*).

Many of our familiar trees are seldom found in a truly wild state, but abound in towns and their suburbs, where they are largely planted for ornamental purposes. This is certainly the case with

the Lime, which is generally stunted in growth through the annual cropping of its branches. The bast used by gardeners to tie up flowers and vegetables is obtained from the inner bark of this tree.

Fig. 541.—The Common Maple (*Acer campestre*)

Fig. 542.—The Sycamore (*Acer pseudoplatanus*).

Another common tree—the Horse-chestnut—is everywhere conspicuous by its showy blossoms and spiny seed-case. It is not by any means a near relative of the Edible or Sweet Chestnut. You

Fig. 543.—The Horse-chestnut (*Æsculus hippocastanum*)

Fig. 544.—The Spindle-tree (*Euonymus Europæa*)

have undoubtedly seen the large buds of this tree in the springtime, and, should you desire to examine the marvellous manner in which the parts of branches lie folded within the protecting scales of buds, you cannot do better than carefully dissect one from the

Horse-chestnut. Within you will find both leaves and flowers in an undeveloped state, waiting for the genial sun to call them forth.

Of course there are a large number of common trees neither

FIG. 545.—THE SLOE OR BLACKTHORN (*Prunus spinosa*).

FIG. 546.—THE BOX (*Buxus sempervirens*).

mentioned nor figured in this short chapter, but it is hoped the selection made is one that will prove of some value to our young country ramblers.

PART III

THE MINERAL WORLD

CHAPTER XVI

MINERALS AND FOSSILS

THE entomologist and the botanist become acquainted with the life of the present day, but the geologist looks back through countless ages, traces the past history of the earth itself, and digs from the rocks relics of ancient forms of life, many of which have now no living representatives. He is brought face to face with unquestionable evidences of such gigantic disturbances, such changes in climate and the conformation of the land, and such remarkable forms of life as might almost pass imagination.

In this short chapter I shall make no attempt to introduce the reader to the study of the rocks and their fossils, but simply give him a few hints on the collection and preparation of the specimens that lie in his path. Such information is not usually given in works on geology, but a simple book on this branch of science will be absolutely necessary to a young collector who desires to understand what he observes, and who intends to put together a collection of rocks, minerals, and fossils that shall prove of real scientific value to the owner.

THE COLLECTOR'S APPARATUS

The outfit required by the geological collector is very simple. A great deal of good work may be done with no other apparatus than an ordinary house hammer and a satchel; but as better and neater work can be accomplished by the use of the proper appliances, and as I take the liberty of assuming that the reader of this chapter is

anxious to do the thing in a professional style, I will briefly enumerate the principal items that constitute the paraphernalia of a real geologist.

First, then, as to the working tools. The geologist's breaking and trimming hammer does not differ much from the ordinary pattern, as will be seen by a glance at fig. 547. Its handle should always project a little beyond the top of the head, and be tightened by means of an iron wedge well driven in; otherwise you may be often provoked by the head slipping off while in the midst of your work.

Fig. 547.—Geologist's Collecting Hammer.

Fig. 548 Duck's Head Hammer.

Fig. 549.—Geologist's Pick.

Some collectors carry a second hammer, like that shown in fig. 548, to assist them in breaking up the larger and harder rock fragments; and also a small pick (fig. 549) for digging into clays and other soft beds. These are not absolutely necessary, of course, for the hammer above described may be used for all the rock-breaking, and a trowel or a large pocket-knife may take the place of the pick. Again, you may even add a fourth implement to your set of breaking-tools in the shape of a small hammer for trimming your rock specimens into a convenient size and shape for the cabinet. This is not generally used in the field, but kept specially for the finishing touches after you have arrived home. Its shape may be just the same as that of the ordinary outdoor hammer, but should be much lighter.

You must remember that your hammers are not to be used only for breaking off and trimming specimens of the rocks you meet with. Some rock-beds contain various forms of fossils, and these have to be carefully removed from the substance in which they are embedded, and cleared as far as possible from all adhering particles. For this work the small hammer and large pocket-knife are both very helpful. A cold chisel is also very useful for breaking hard specimens, especially when you find occasion to be particular concerning the exact place and direction of the fracture.

The best way to carry your hammers is to support them in a strong leather belt; and you will certainly be far more comfortable if the weight is shared partly by the shoulders. I have managed this by fixing the belt to an ordinary pair of trouser-braces.

So much, then, for the working tools. But there are a few other matters to be considered. You will require a strong satchel for your specimens, and some material in which to wrap them up. For the majority of minerals and fossils nothing is better as a wrapping than pieces of newspaper. This should always be torn or cut into squares of convenient size before you start on the collecting trip. But you will often meet with specimens of such a fragile nature that special care will be necessary in packing them away. These had better be wrapped in wadding and placed in small boxes; or they may be put into boxes of bran or sawdust.

A pocket lens is useful for examining the structure of rocks and fossils, though it is generally at home, rather than in the field, that you study your specimens minutely.

In the Field

The equipment is ready, and now comes the important question—'Where shall we go?' Beginners are apt to think that their success will be in direct proportion to the distance over which they travel in order to reach the collecting ground. A greater mistake you could not make. Are you now contemplating your first geological expedition? Then begin at home. On what does the foundation of your own residence rest? Is there nothing beneath your feet that has an interesting tale to unfold? It seems to me that, however barren one's own district *appears* to be from a geological point of view, the study of rocks should always begin at home; and, when we have learned to understand something of the

nature and formation of the beds with which we are so familiar, then we have established a centre from which we can gradually and intelligently extend our labours into the less-known and unknown grounds.

But, say you, 'There are *no* rocks in our district: we have nothing but clays and gravels; and no fossils of any kind have we ever seen in them.' Every gravel-bed, or clay-bed, however, has its history, and a history that is always worth knowing. A careful examination of the beds and their surroundings may reveal to you various circumstances under which they were deposited; and, if you *should* find any fossils, how interesting it will be to associate the bygone ages with the life of the time, and to compare these ancient forms of life with the living species of the present time!

At any rate, whether our excursion is close home or at a distance, our method of examining the rocks and collecting specimens is precisely the same. We take advantage of those spots where the rocks peep through the soil. Railway cuttings, quarries, chalk-pits, gravel-pits, sand-pits, river beds, and sea cliffs all afford to the geologist splendid opportunities of carrying on his investigations and collecting his treasures; and, where such natural and artificial exposures are not to be met with, he will sometimes find it necessary to remove the surface soil here and there in order to see what lies beneath.

In all cases the note-book should be in constant demand. The nature and extent of all rock-beds should be entered wherever possible; and it is always interesting to note how the natural scenery and the nature of the vegetation change as we pass from one bed to another.

Some rocks you will find in horizontal layers, not having been much disturbed since first deposited; but others show signs of violent forces, for they are not only broken up and thrown into inclined positions, but may be contorted into all manner of fantastic shapes, and sometimes pushed into a vertical position, or even quite inverted. Then there are the hard and crystalline *igneous* rocks occurring in very irregular masses, and exhibiting traces of the very high temperatures which accompanied their formation.

You will be likely to derive much more satisfaction in 'doing' a certain district thoroughly than by searching at random in a number of isolated localities; and if you desire to try this you should provide yourself with the 'Geological Survey' map of the

district you select. This will give you every minute detail of the surface rocks, and wonderfully assist you in your expeditions. In this case, too, a pocket compass will prove a useful accessory.

Now a few hints as to the actual collecting. First let us suppose that we are among hard and rugged rocks, of which a few specimens are required. The heavy hammer is brought to play on a piece which exhibits the structure well, and a portion of suitable size is broken off for the cabinet. It may be roughly trimmed with the smaller hammer before placing it in the satchel, leaving the final shaping, if such is necessary, to be done at home. When dealing with such hard rocks it is not uncommon for the hammer to slip from the hand, but this may be avoided by filing some furrows in the handle to assist your grip, or by rubbing the handle with bees-wax.

The cold chisel is useful when you desire to break a hard rock in a particular position and direction. Hold the chisel firmly in its place with the left hand, and give a heavy blow with the right. Perhaps you miss your aim, and receive the full force of the blow on your tender knuckles; but you can provide against a repetition of this mishap by covering your hand with a piece of very thick leather, in which is a hole just large enough to enable it to pass over the chisel.

Many rocks are worn away on their exposed surfaces by the action of the atmosphere. In this condition they are described as 'weathered,' and should, as a rule, be avoided. But in a number of instances the weathered specimens exhibit certain peculiarities which are not to be seen in newly-exposed fragments, so that it will be useful to have these for the cabinet. As a striking instance I may mention the hard limestones of the West of England. These are often full of the most beautiful fossils, consisting principally of corals and shells. So compact are they that it is impossible to remove the organic remains; and the fossils can be studied only by making sections and polishing the surfaces of the fragments. But if you search along the foot of the cliffs formed by such limestones you are sure to meet with portions that have long been exposed to atmospheric agencies, and these will often show the fossils in bold relief, the softer parts having been worn away more than the harder portions.

The removal of fossils from beds of softer materials, such as clay and chalk, is, of course, a very easy matter; but the greatest care will be required sometimes in getting out the specimens whole.

The knife is more useful than the hammer for such as these; but as the final clearing requires great care it should be left till you have leisure at home.

Preparation and Arrangement of Specimens

When you reach home after your geological trip, you lay out all your specimens on a table, so that you can readily cast your eye on any one. You will probably have some valuable or very fragile ones that require immediate care and attention. Put these together first; and then wrap up all the others, and put them aside till you have the time to see to them; but be careful to inclose a temporary label with each one, containing any particulars you are likely to require.

Now is the time to study your treasures. You had but little opportunity for this in the field, for you were then too busy with your tools to examine them very closely. So now, as you trim and repair the specimens for the cabinet, with lens in hand, and books of reference open before you, each rock fragment and fossil is made to unfold its romantic history, and to tell of the wonderful changes which the earth, now wrinkled with age, has seen in its more youthful days. Sometimes the most careful examination of the specimens and the most vigorous searching through the pages of your geological works fail to give you satisfactory evidence of their identity. In such cases, even when there is only a faint shadow of doubt, consult one of your reliable geological friends, or pay a visit to one of our public museums, before you finally label them and decide on the places they are to occupy in the cabinet.

You may have some fragile and broken fossils. If so, deal with them thus: The broken ones may be mended by a little cement, and then set aside in little boxes of cotton wool. As to the cement, nothing is better than a solution of isinglass in acetic acid. To prepare this, put about an ounce of isinglass in a bottle, add a *very little* acetic acid, and mix the ingredients well while the bottle stands in a dish of hot water. No more acetic acid should be used than is necessary to form a rather thick glue, which should always be warmed before use by standing the bottle in hot water.

Some fragile fossils possess the annoying propensity of crumbling to dust after they have been safely lodged in the cabinet; but this tendency may be overcome by treating them as follows: First make a *very thin* glue in the ordinary way. When this is ready,

place before you two vessels, one containing the hot glue, and the other hot water. Immerse the fragile fossils, one by one in the water; and, when thoroughly warmed, plunge them into the glue for a few seconds. Immediately on removing them from the glue, remove all the superfluous liquid by means of blotting-paper, and set them aside to dry. If, after drying, they present an unnatural varnished appearance, this may be reduced by brushing them over gently with hot water.

Before your glue cools down, stir into it a little spirit of wine, and then run it into a bottle which is afterwards well corked. The spirit will keep it good for any length of time, and it is always ready for use after standing in hot water for a few minutes.

Many of the fossil fruits can never be preserved satisfactorily in a dry state, but they generally do well in bottles or tubes of glycerine.

The size to which you trim your specimens of rocks and minerals must depend largely on the space at your disposal. As a rule they need not be larger than two inches square; but, if you have plenty of space, larger specimens will in some cases be better. Don't shape them into regular geometrical forms, and always let them expose a surface that has not been touched with a tool.

In shaping a very hard rock you may at first have some difficulty in making it break just in the right place and in the right direction. The best plan is to hold it firmly in the left hand, with the part you intend to remove nearest you; and then strike it obliquely towards yourself with the narrow edge of your trimming hammer.

Now just a word or two about your geological cabinet. By all means obtain a good museum cabinet if you can either afford it or make it; but if you cannot, your collection will be just as valuable stored in ordinary shallow boxes such as can be obtained from the grocer's. Whatever kind of boxes or drawers you use, the specimens must be arranged in such a way that they will not shake about and knock together. This may be managed by placing a number of partitions across to divide the space into little squares, or each specimen may be put into a little cardboard tray. Small and fragile specimens should be kept in glass-topped boxes, so that they may be examined without risk of damaging them by removal.

After you have given a little time to the study of geology you will be able to arrange all your specimens in scientific order, using either the comparative age or the chemical composition as your guide.

I have now endeavoured, so far as space would permit, to lead my young readers to take an active interest in all three of the great kingdoms that make up our material surroundings; and, in conclusion, may I urge them not to become mere collectors? You may have very commodious cabinets, well filled with a great variety of natural objects of all kinds; further, you may give forth their long Latin names with a speed that will strike all your friends with awe and admiration. Yet with all this you may not be a true naturalist. See that you *know* all your specimens—that you are acquainted with their real character, and with the part played by each in the realm of Nature. Study the animals while they live; examine the flowers before they fade; and observe the arrangement of the rocks and fossils while you are yet in the field. Then the specimens in your cabinets, though faded and shrivelled and incomplete, will always tell you of the real life which they represent; and the useful labels and notes which accompany your treasures will be full of living interest.

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NOTE:—*References are given where species are figured but not described.*

PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
LONDON